August 16, 1928

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Engineering News-Record

McGraw-Hill Publishing Company, Inc.

Devoted to Civil Engineering and Contracting

Open Cofferdams for Hudson River Bridge Pier at New York

Deep Open Cofferdams Used for Hudson River Bridge Piers

By R. L. TELFORD, *Engineer, Mason & Hanger Co.*

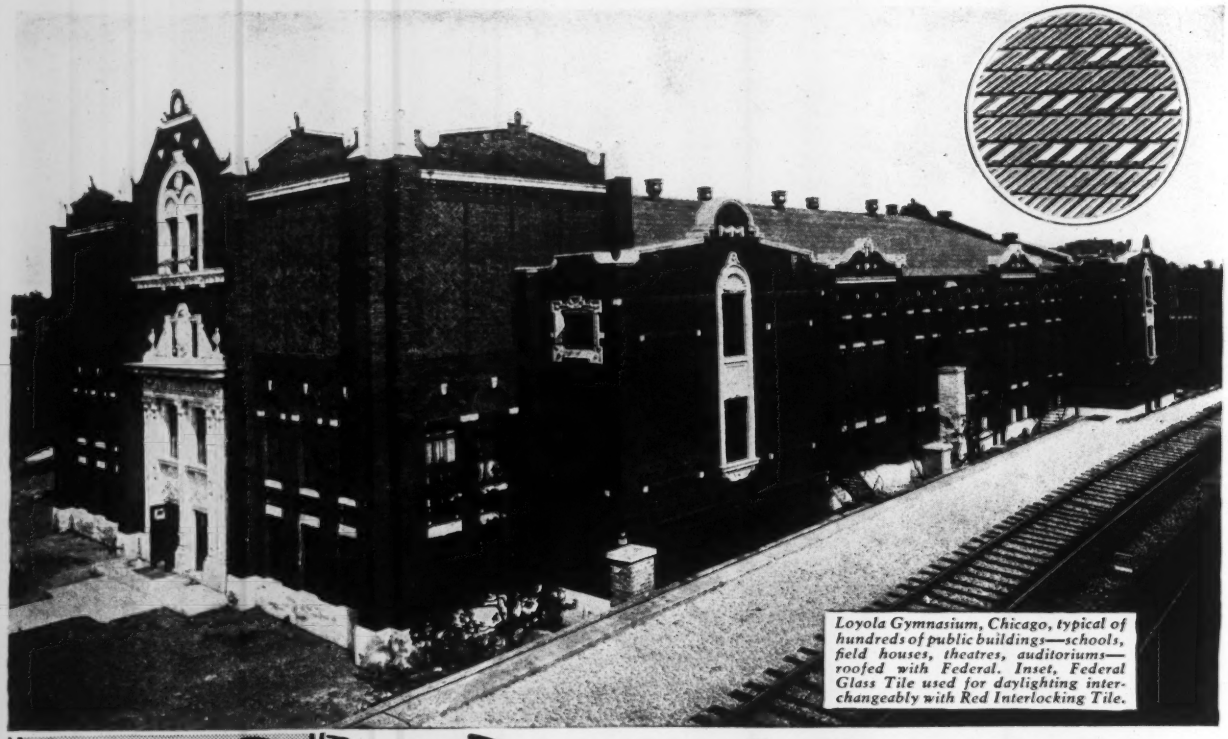
Sewerage System of the City of Caracas, Venezuela

By THORNDIKE SAVILLE, *Professor of Hydraulic and Sanitary Engineering, University of North Carolina*

Also a Notable Article on

Strain Effects in Mild Steel

By HENRY S RAWDON, *Senior Metallurgist, Bureau of Standards, Washington, D. C.*



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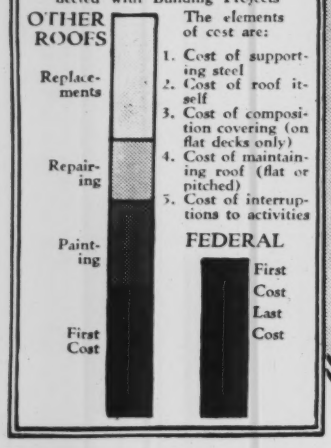

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Pressure line is outside of middle third even without considering uplift. Masonry facing probably not effective section.

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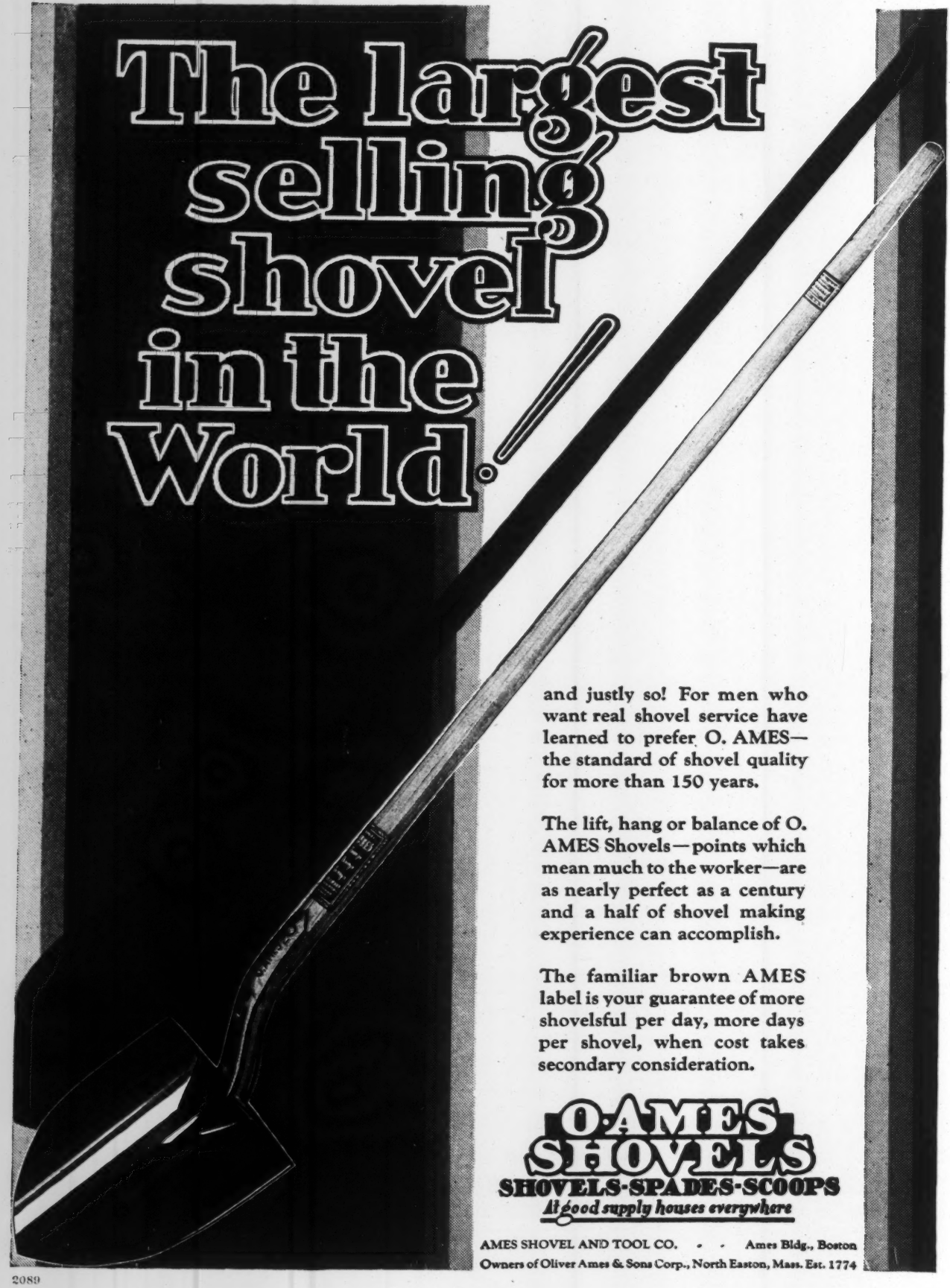

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Volume 101 NEW YORK, AUGUST 16, 1928 Number 7

Heel and Toe

THERE is no confusion in the meaning of the terms heel and toe when applied to dams of simple gravity section. Perhaps these terms originated in the fact that in such sections there is a rather rough resemblance to the human foot. Universally the term "heel" is applied to the bottom of the steep upstream face, while "toe" is the term used for the point on the base farthest downstream. If in this case the heel is the base of the steeper slope and the toe is the intersection of the base with a lesser slope—since the downstream face of a gravity dam is invariably flatter than the upstream face—the situation is a little different in other types of dams, and here often proves confusing. The multiple-arch dam, for example, has the steepest slope on the downstream face of the buttresses, and there is an obvious temptation to reverse the application of "heel" and "toe" as compared with the gravity section. The mere shape of the section, thus, is not a sure guide to identifying heel and toe. Because of the long-established usage, however, it is desirable that practice be kept consistent, and that in any dam, regardless of type, "toe" should invariably be applied to the portion of the base farthest downstream.

Corrasion and Corrosion

SCIENTIFIC terminology has some singular features. As though its intrinsic difficulties were not enough, scientists at times establish confusing and irritating similarities of terms—for example, in the well-known pair "absorb" and "adsorb," which physical chemists employ so much. A most annoying case of this deliberate creation of confusion is found in a term used by geologists and physiographers and occasionally carried over into engineering literature—namely, "corrasion," a synonym for erosion due to mechanical actions. Its deceptive likeness to the everyday word corrosion should be a sufficient reason against its use. Clearness is a vital need of the language of science as well as that of engineering, and with the fast growing complexity of technical language it is important that care be taken to avoid special pitfalls to ready understanding. So far as engineers can assist in clarifying terminology, it will be well for them to ban the needless term "corrasion" from their vocabulary, and they may find opportunity also to influence their scientific friends in the same direction. Confusion of terms too easily produces confusion of thought.

A Bad Word

HOW words may influence thought in a harmful way is shown anew in the field of dams, where the word "sliding" is in everyday use. It is an outworn relic from the early days of the engineering study on masonry dams, when these structures were full of horizontal bedding planes on which sliding could be conceived to occur. Today the concept of sliding, with its associated concept of a frictional resistance that prevents sliding, no longer has meaning, but survives only as a seriously narrowing influence. When the engineer plans a set of stop logs to close a water chute, he does not think in terms of sliding and friction, but he fixes his stop logs securely in deep recesses able to hold against the pressure of the water beyond peradventure. When he plans a dam, however, the old concept of sliding comes to mind, and he is satisfied to set his dam on a simple foundation surface, so long as the calculated vertical pressures at toe and heel are not too high for the bearing power of the foundation and the downstream shove of the water is not large enough to overcome the frictional resistance of the foundation. Great dams have gone out in disastrous collapse because of this reliance on sliding friction—the two Austin dams, for example, and more recently the Gleno dam and (under rather different circumstances) the St. Francis dam. Had the practice of dam engineering always been founded on the thought of bedding and locking the structure securely into its foundation, it is likely that these four great structures would still be in service. Certain it is that the entire art of building dams would be the gainer if the concept of sliding and foundation friction could be eliminated from the civil engineer's thinking.

Bond Issue Campaigns

SUCCESS in "selling" any public improvement is predicated upon the same combination of facts that govern any other selling transaction. Assuming a need or a desire for the thing to be sold, success depends upon its excellence and upon the ability of the seller adequately to picture it to the buyer. Because shortcomings on the latter score have repeatedly defeated necessary bond issues in many parts of the country, the methods which spelled success for a $6,500,000 issue of twenty-year county-road bonds in Jackson County, Missouri, are worthy of emulation. In the first place, the project was lifted entirely free of the political systems of both the county and metropolitan Kansas City by appointing two outstanding engineers of opposite political affiliation a commission to analyze and make recommendations for the system. Incidentally, the same two engineers will be in active charge of the construction work. The plan they submitted to the voters after their survey and analysis was a model of engineering method. Each voter received a folder containing a map on which was marked every road which would be benefited. The folder further included an extended discussion of the project, pointing out what it meant to the county and describing it in detail. Nothing was left to the voter's imagination. He knew just what his money would be spent for. Each road was named and the length and width to be paved were given, together with the estimated cost. The total of the estimated costs equaled the sum of the bond issue.

In addition, each voter knew that the proposed program would cost him annually seven cents for every $100 of assessed valuation on his property. The slogan of the engineers in presenting their recommendation was to be brutally frank. The result was that this bond issue carried in an election in which other issues not so well buttressed with fact were overwhelmingly defeated. The lesson taught is that honesty paints the picture that the voter wants; in brief that it is the best policy. More public improvement bond issues would pass if their sponsors followed Jackson County's methods.

Abjure Code and Rule

CODE and rule have a strong appeal to bureaucracy. Their connotation of law and regulation are relished by public safety officials, who like to feel that they have something specific to enforce and would rather apply rule than create safety intelligence by educational methods. So the public agents for preventing accidents urge the adoption of rules for safe construction. They have strong allies in the field of accident-compensation insurance, for, with rules laid down, casualty officials have a definite measure by which they can determine infraction and justify contest. Thus, thinking and talking code and rule are natural to the actuary and the enforcement officer. But they are not natural to the construction manager. He is dealing with flexible and fluid conditions and processes; safe practices to day will not be safe practices tomorrow. And he knows that a large percentage of all accidents come from causes which no mandatory regulations can be devised to overcome. He instinctively contemns any code or rule, whether for preventing accidents or for directing any other part of his work. Construction management does not lend itself to codification or to direction by rule. It does admit of general principles of guidance and control, and among them general principles of safe construction have their proper place. Their inscription and the drafting of instructions are welcomed by constructors. Indeed many of the leading construction companies have safety manuals of their own preparation. These, however, are manuals of good practice instead of tight codes which cannot quickly accommodate themselves to new methods of construction. It is a similar manual of instructions which the sectional committee under the direction of the American Engineering Standards Committee is undertaking to develop, as noted in our current news section. The delegates to this committee represent an impressive list of the organizations concerned in safe construction practices. Let them then wipe the terms code and rule from the nomenclature as well as from the thought and purpose of their work.

Bids Less Than Estimates Again

WHAT is the ethical aspect of the common practice, indulged in by public-works officials and by some engineers, of giving wide publicity to and claiming credit for savings effected by contracts carried out at bid prices less than the engineers' cost estimates? A correspondent in this issue, in commenting on the editorial note published two weeks ago under the title "Bids Less Than Estimates," affords the opportunity of asking the question, which was passed by but not overlooked in writing that editorial. If, as our correspondent suggests, engineers' estimates do not represent their judgment of actual costs but are set at some higher figure adopted for administrative purposes and with the knowledge that any bid to be considered must be under the estimate, then what justification have they for claiming as a saving to the public the difference between the bid price and the estimated cost? It is not only in highway work that this is being done. In the Borough of Queens, New York City, a new administration replacing a previous one forced out under charges of extravagance and graft is writing its record of economy in a rapidly mounting total of savings counted by summing up the differences between contract prices and engineers' estimates on contracts being let for public works. Other examples are so plentiful that no more need be cited. Moreover, many well-intentioned officials are merely following custom in making the claims of savings. The cost comparisons also are subject to variation, because engineers' estimates do not always mean actual construction costs but often include costs of engineering design and supervision and various departmental overhead charges which form no part of the contractor's price. Clearly, when public-works directors compare to their credit the prices paid with the costs estimated they do not mean to mislead; they err by impulsively grasping an opportunity to filch a little applause for a vocation which does not bring great public acclaim. Nevertheless engineers in particular might well seriously consider whether the practice measures up with that complete rectitude which is the proud boast of engineering.

Engineering as an Art

ENGINEERING rests squarely on the foundation of science. Mathematics, mechanics and study of materials and structures play their part in furnishing the groundwork on which is reared its magnificent structure as it exists today. But beyond this, let it be remembered that engineering still is an art, as it was a century and more ago.

The work of the engineer is not amenable to formula or rule, and few if any of the decisions he must reach can be determined upon by setting the data on a calculating machine and moving a slide or turning levers to get the result. It is true that each new bit of advanced knowledge—and research is pushing knowledge forward at a rapid rate—seems to eliminate a former item of judgment and replace it by law or rule. But the soundest engineering nevertheless is that which utilizes these analytical agencies only as auxiliaries and does not permit them to dictate its conclusions. At the present moment, when civil engineering has rounded out its century, we shall do well to call this to mind.

It is the art, rather than the data and sciences on which it is based, that constitutes the objective of a lifetime of engineering training. Daily habits may lead the engineer toward increased reverence for stress analysis, or proof by test; yet neither the one nor the other fully represents and replaces the ultimate desideratum—namely, long-time stability and service of the constructed work. Constantly we aim to make the laboratory forecast and parallel the expected service results of the future; constantly we aim to compute on paper the chance event—whether flood, or weather resistance, or unit stress—which the finished work will some time experience. And in the habitual succession of these attempts we often half believe that the whole problem of our planning has been caught and caged within the four walls of the test room or bound between the covers of the computer's book. But the art still remains an art.

It is of some value to recognize that even much of our current engineering literature tends to lead away from this understanding. The literature of the newer day includes not only that part which is concerned with the application of engineering science as an aid or enlightenment of the practical art but also a part which goes beyond this well-bounded range and attempts to read into analysis and test a power to furnish the final solution of engineering questions. In that attempt resides a danger. It may lend authority to unsound conclusions, and, what is still more serious, it may have the effect of inducing others to stray away from true recognition of the abiding function of trained intuition in the practice of the art.

There will no doubt always be conflict between the two views. It is difficult to reconcile them in explicit terms. With the advance of the world all progress that is made must tend to shift the balance toward the side of a more exact science, and bit by bit will bring a larger range of questions within the compass of predetermination. But for all that it is of utmost importance to appreciate the limitations of precise methods. And the problems of present-day engineering bring us face to face with many situations where such appreciation is vital. When the engineer is tempted to proportion a railway bridge from calculated stresses within limits of fractional per cents; when he observes an attempt made to set up rules for building safe dams; when he is asked to fix his working stresses for timber or steel by ratios and calculations; when he is confronted by the belief that building codes make buildings safe; when levee slopes fixed by uniform rule are expected to give protection to the entire thousand miles of the Mississippi Valley—in the face of these daily tendencies toward crystallizing the engineer's function into positively formulated statements, he may well keep in mind the underlying fact that engineering is an art.

Foundations in Soft Mud

EVEN in oldest times, as well as today, builders encountered their greatest problems in constructing foundations in the soft bottom of lakes or rivers. For thousands of years their methods progressed but little. Cofferdamming was in a primitive stage as late as the beginning of the last century, according to the account given by Daniel E. Moran in the semi-centennial number of *Engineering News-Record* four years ago. Later, the open-cylinder and pneumatic-caisson processes were developed, soon becoming the methods of greatest resource under difficult conditions; and, finally, recent years have witnessed a new flourishing of the art of cofferdamming, through the new possibilities of strong sheetpiling. In this new art a high peak of achievement was reached within the present year, in the successful construction of two large piers on shelving rock nearly 80 ft. below water and buried under 50 ft. of mud and clay, for the west tower of the Hudson River bridge.

Unless this course of development be kept in mind, the straightforward description of the Hudson River work which the contractor's resident engineer gives on another page may make the enterprise seem soberly conventional and without incident. It was, in fact, unusually free from obvious complications; but this is to be credited to the great care used in planning every detail of the work and to scrupulous watchfulness exercised in the field. The boldness of the conception is witnessed by the fact that even when the enterprise was well under way there were many able engineers who shook their heads as to its outcome.

The Port Authority's engineers and the contractors had each a share in the conception. The specifications as first drawn contemplated only pneumatic caisson work, but when final boring results became available and the problem was restudied by the engineers and their foundation consultant, they foresaw the feasibility and the probable superior economy of construction in open cofferdams with the aid of long steel sheetpiles, as just then being used with great success by the H. P. Converse Company in building the piers of the Arlington bridge at Washington, to a depth of some 50 ft. In the Hudson a much greater depth and larger size cofferdams had to be faced, but it seemed certain that these factors could be dealt with by previously demonstrated methods of constructing bracing that would be effectively rigid against the great pressures to be resisted—one and a half to possibly more than two tons per square foot of skin surface. Accordingly the specifications were redrafted to invite bids on either pneumatic or open construction. There were seven pneumatic and six open-construction bids; and, as had been thought likely, the lowest bid submitted was on open work. The final event proved that Silas B. Mason and Francis Donaldson, who developed the project, had analyzed the engineering and construction problems to be solved with remarkable keenness and prevision.

It is worth recording the fact that even in the earlier and less extreme case of the Arlington bridge piers, the proposals of the bidders were studied very carefully by the engineers of that undertaking before deciding to award the contract to the lowest bidder, as they entertained serious misgivings about the safety of the open method proposed by him. The outcome of the work, however, justified the faith of the Converse firm in its plan. Naturally, the proposals for the Hudson River piers were subjected to even more thorough scrutiny, in view of the far more severe conditions. It is gratifying that both parties maintained their faith in the method, thus enabling its success to be demonstrated.

With the jagged and sloping foundation surface revealed by the actual excavation, it now appears that construction by the pneumatic process would have faced very serious difficulties. In place of each cofferdam there would doubtless have been several caissons; not only would each of the outshore caissons have had to be sunk to a considerable depth below the cutting edge of its inshore neighbor but it would have required either sinking for some distance through part-rock bottom or else hazardous excavation through soft ground below the outshore cutting edge. In view of the cost and hazard of these alternative possibilities, it may be that the open method as executed in this case has an advantage not only in cost but also in simplicity and power.

Essentially, the work was made possible only by the great resource afforded the constructor by long interlocking steel sheetpiling. The progress made by the aid of this modern expedient is a logical development from that begun thirty or forty years ago through the adoption of composite heavy timber sheetpiles, but it goes far indeed beyond the scope of that older device. The steel sheetpile, coupled with resort to cellular double-wall construction on the main part of the cofferdam periphery, and finally with use of concrete filling for the lower part of the deep cells—a happy afterthought—was what made possible the work at Fort Lee.

Fig. 1—View of Completed Piers, New Jersey Tower of Hudson River Bridge. Note Concrete Plant in Left Foreground; Wrecking of Dams and Dismantling of Plant Under Way.

Deep Cofferdam for Hudson River Bridge

Two Cofferdams of Steel Sheet Piles Driven 80 Ft. to Rock Braced by Box Frameworks of Timber Sunk Prior to Piledriving Only One Serious Blow-In Experienced

By R. L. Telford

Engineer, Mason & Hanger Company, Contractors, New York, N. Y.

COFFERDAMS in 79 ft. of water requiring steel sheet piles 85 ft. long were successfully braced and kept tight on a steep slope of jagged rock in building the masonry twin piers for the New Jersey tower of the Hudson River suspension bridge at New York. This bold resort to open coffer operations for so deep a foundation called for care and skill, but at no time were there experienced the hazards which it had been freely predicted would bring disaster. Well-conceived advance plans and construction skill in their execution made the work so rapid that it bore the appearance of being almost commonplace. In fact, it ranks as one of the deepest cofferdam operations ever undertaken for subaqueous foundations and stands as an advanced development in this class of construction.

Pier Structure—The completed twin piers are shown by Fig. 1. To an elevation 15 ft. below mean tide level each is 89x98 ft., the long side being in the direction of the bridge. At 15 ft. below tide the masonry steps into a shaft 84½x76 ft., and these dimensions continue to the top at 15 ft. above mean tide. For the top 24 ft. the piers are faced with granite ashlar in 3-ft. courses of Stony Creek pink granite. The sketch, Fig. 2, shows the pier dimensions. Figs. 1 and 3 indicate the pier locations. They are 153½ ft. apart on centers and the inshore ends are about 30 ft. from shore.

Thirty core borings indicated that the bedrock upon which the piers were to be founded sloped steeply toward the river, its depth below mean tide varying from 32 to 38 ft. at the inshore ends and from 65 to 79 ft. at the outshore ends, as indicated by Fig. 2. The rock cores showed alternate beds of red shale and soft and hard sandstone. Overlying the rock was a stratum of shells and sand 4 or 5 ft. thick, and above that the Hudson River silt, ranging in consistency from fairly stiff clay at the bottom to almost fluid mud at the top. The depth of water at the site was about 15 ft.

Design of Cofferdam—A cofferdam was built for each pier, as shown by Fig. 3. The waling and bracing was designed as timber frames around continuous vertical posts, so each frame could be built at the water surface and be sunk by the weight of the one above it. The outside rangers, or walings, were 24- and 30-in. I-beams. Figs. 3, 4 and 5 and several of the views show the framing.

Each frame had five longitudinal and five transverse struts abutting against the I-beam rangers, the transverse struts passing above the longitudinal. Each strut consisted of a pair of timbers breaking joints separated by the width of the vertical post and having filler blocks at each joint. The struts varied in size from 6x12 in. at the top to 10x14 in. at the bottom. The I-beam rangers were supported by timber brackets bolted to the under side of the struts and extending beyond the strut ends for the width of the beam (Fig. 4). Where the corners overlapped, they were secured by thrust plates bolted to the inner flanges (Fig. 5).

In the original plan four horizontal frames were provided and one inclined frame designed to support the deep outer wall as far down as possible; subsequently a

second inclined frame was added (Fig. 4) to reduce the stresses on the lower struts. Simple hydrostatic pressure was the basis for estimating stresses, the influence of the silt and mud being disregarded. The sizes of the beams and timbers used are indicated on the drawing in Fig. 4. The over-all dimensions of the frames were 10 ft. greater in both directions than those of the pier, so as to provide a 5-ft. clearance all the way around.

The sheet piling plans for the two cofferdams were identical. The east, or outshore, end and four-fifths of both adjacent sides (Fig. 3) were formed by two lines of piling 7 ft. 10½ in. apart, connected by diaphragm walls over 10½ ft. The remainder of the wall consisted of a single line of sheet piles.

The sheet piles used weighed 32.9 lb. per foot and varied in length from 40 to 85 ft. A total of 1,558 tons of sheeting was required for the two cofferdams. It was planned to fill the pockets in the walls and to bank

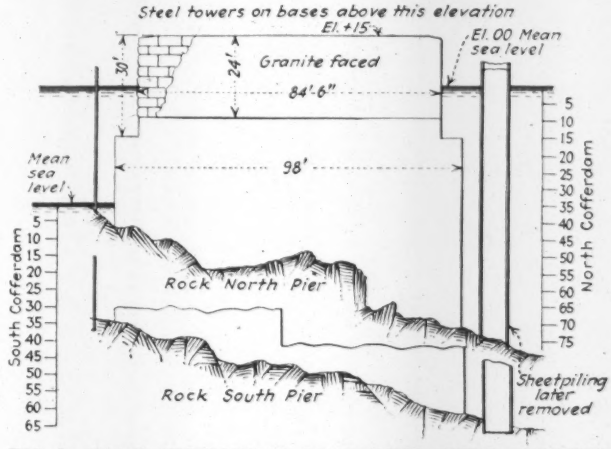


FIG. 2—CROSS-SECTIONS OF COMPLETED PIERS, SHOWING ROCK SURFACES

the entire cofferdam on the outside with a mixture of sand and river mud, the backfill outside the single wall being brought up almost to water level. As explained later, this proved inadequate and some of the pockets were filled part way up with concrete.

Construction of Cofferdams—The first operation was to dredge the entire area to rock inshore and to El. —45 at the outside edges of the cofferdams. Dredging was started early in May, 1927. More than 75,000 cu.yd. was dug in twenty days, and then several large boulders and a rock-filled crib on the landward side of the excavation were encountered. It was necessary to employ divers to drill and blast these obstructions, and ten days were required to remove them.

Immediately after dredging the construction of the frames was started. Four derrick boats were used to place the struts and I-beam rangers. The frames were held in position by braced guide piles and supported by

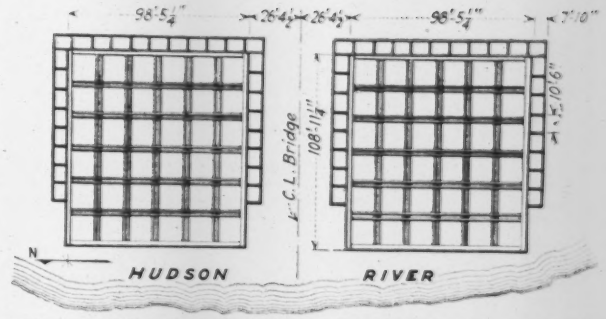


FIG. 3—GENERAL PLAN OF TWIN COFFERDAMS, SHOWING CELLULAR WALLS

tackles from nine pile towers driven within the bays of the framework of each cofferdam. The tackles were attached to cross-logs beneath the bottom frame. The frames (Fig. 6) were allowed to sink as each set was completed. Further work by divers was required in sinking the framework to the intended depth. Several hundred yards of riprap, boulders and logs were removed from beneath the framework and the inner line of sheet piling before the cofferdams could be sealed.

Piledriving was started July 31, 1927. Steam hammers were used, both with and without swinging leads. A set of overhanging sliding leads mounted on a floating piledriver drove "home" the piles of the inside wall after they had been set by a derrick boat. The greatest difficulty in seating the piling was met in driving the shore ends on account of interference by the remains of the crib. It was impossible to prevent the tops of the longer piles from creeping ahead, consequently a specially fabricated wedge-shaped pile was inserted before the final closure could be made. Careful supervision of the seating was maintained at all times.

As the piledriving progressed it became evident that the silt below El. —45 was much less stable than had been expected and that some means more positively to seal the bottom of the wall and to strengthen the unsupported portion below the bottom ranger would be advisable. The greatest span below the bottom ranger to the toe of the piling, in excess of 30 ft., was on the east wall of the north cofferdam. This required concrete to be placed in all the pockets along the east wall and also in the four adjacent pockets along the north and south

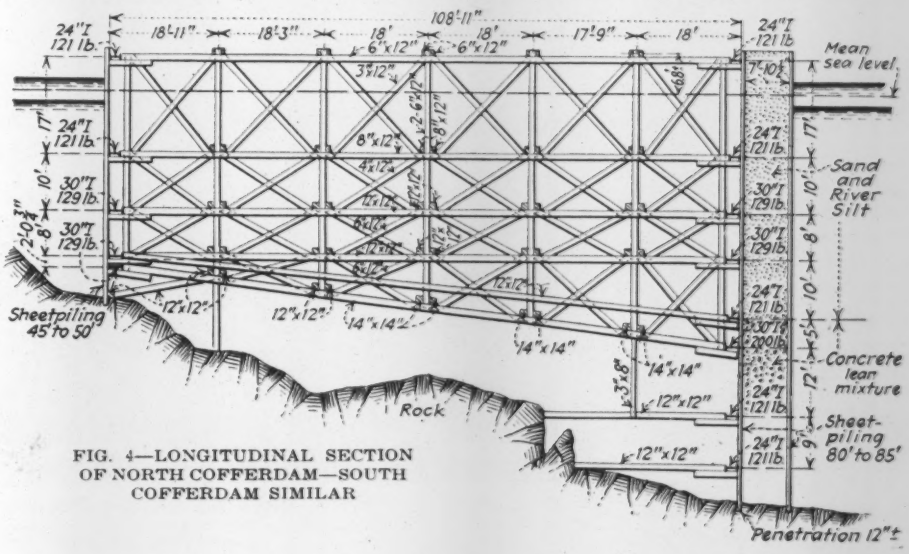


FIG. 4—LONGITUDINAL SECTION OF NORTH COFFERDAM—SOUTH COFFERDAM SIMILAR

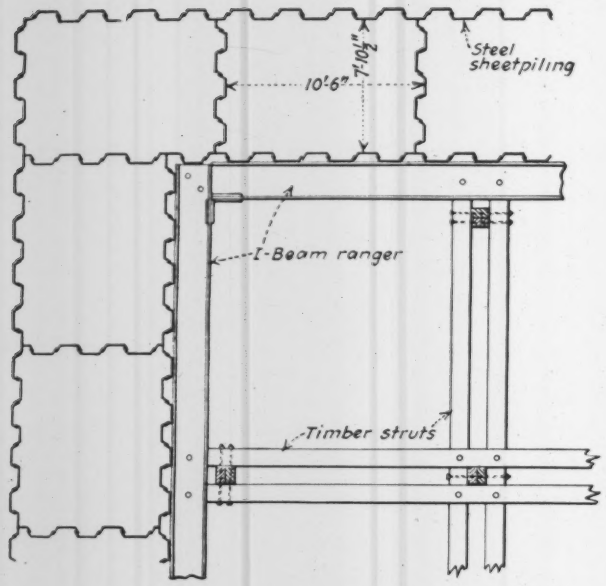


FIG. 5—DETAIL OF COFFERDAM CORNER

sides. The south pier was similarly treated. The pockets were alternately dredged and filled with concrete. A derrick boat did the dredging, while the concrete was poured from a floating plant. Great pains were taken to clean the bedrock in the pockets before the concrete was placed, and doubtful pockets were inspected by a diver before concreting. The utmost care was also taken in placing concrete under water in the pockets. Using a 1-cu.yd. two-line covered bucket, precautions were taken to see that every bucket carried a full load, flush with the cover, which was carefully seated to exclude any rush of water. The buckets were lowered at a uniform rate and slowly seated on the bottom before being dumped. Sand backfill mixed with river mud was used above the concrete and also in the undredged pockets and behind the single pile wall as was originally planned. A cross-section of the filled pockets is shown in Fig. 4 and a view of the completed cofferdams in Fig. 7.

Pumping and Excavation—Both cofferdams were unwatered without difficulty. In each case one 12-in. and one 8-in. vertical submerged centrifugal pump was used. When each dam was entirely unwatered and excavated, a 4-in. horizontal centrifugal pump running at intervals took care of all seepage. The water was lowered in stages to allow time to wedge behind all the rangers where the sheet piles were not taking a bearing.

Excavation commenced on the landward or high side of the cofferdam as soon as the bottom appeared. Soft materials were in part dug out with clamshell buckets. Large quantities were also washed to the pumps with high-pressure water jets and pumped out. Rock excavation was hand loaded into scale boxes and hoisted out.

The strata of the bedrock inclined toward the shore, with thick beds of sound white sandstone alternating with seams of red shale only a few inches thick. When the gorge was eroded, the sandstone ledges had broken off at right angles to their bedding planes and had thus formed a series of natural steps and created an ideal foundation for the piers (Fig. 8). The steps were found filled with sandstone fragments embedded in disintegrated shale, partly reindurated. This material was loosened with air picks, and blasting was required only to break up the larger sandstone fragments and occasional traprock boulders.

The south cofferdam was entirely excavated without the need of timbering other than that in the sunken frame. In the deepest part of the north cofferdam as the excavation progressed two additional I-beam rangers were placed below the original framing. These rangers were spaced about 8 ft. apart vertically and were braced with struts suspended from the struts of the main frame and seated in hitches cut in the rock slope. All additional struts were wedged tight with steel wedges.

The foundation concrete was placed in blocks as the bottom was prepared, working progressively down hill from the inshore ends. Each block was carried high enough to embed the lower timbers of the sunken frame. At the bottom the concrete was permitted to extend beyond the neat line of the pier to a direct contact with the sheet piling. Forms were rough framed against the posts and struts.

Cofferdam Blows—Two minor blows occurred in the south cofferdam during the progress of excavating. These were both in the back wall and were quickly remedied by dumping sandbags and cinders in the water outside directly above the blow and by driving down the piles affected. On Dec. 23 the north cofferdam suffered a serious blow. The single piling on the north side between the northwest corner and the first pocket encountered a depression in the rock extending about 10 ft. below the bottom ranger to a total depth of 47 ft. These

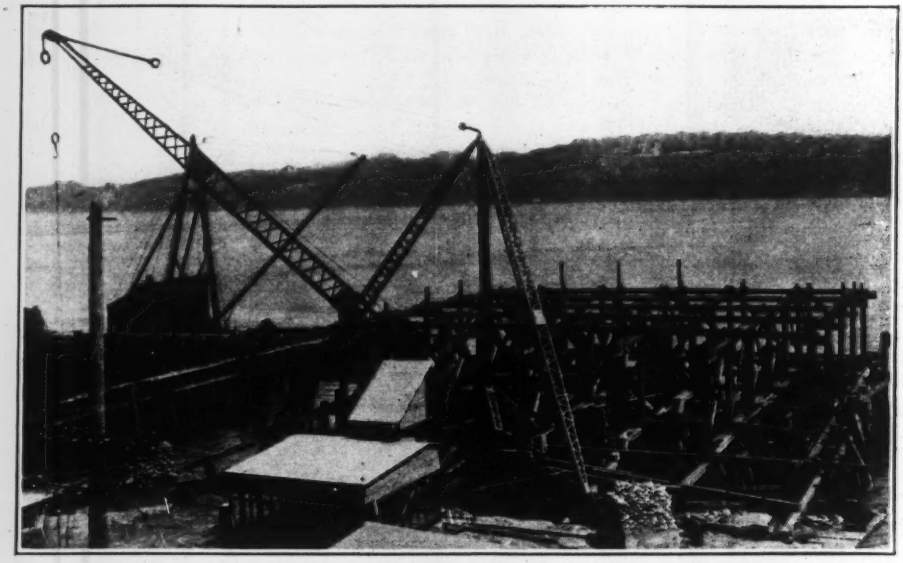


FIG. 6—FRAMING AND SINKING TIMBER BRACING
North cofferdam framework in final position and south cofferdam framework only partly sunk.

piles had been driven a foot or more into firm red shale. The cofferdam had been unwatered for some time, a block of concrete for the permanent structure had been placed in the southwest corner and the foundation had been excavated along the remainder of the west end for a width of about 20 ft. ready for placing concrete. The piles showed no leakage whatever or sign of strain. Early in the morning before the day shift had started work the shale into which the piles were driven gave way without warning for a stretch of 6 or 8 ft. The points of the piles, being thus released, bent inward at the bottom and a rush of sand and water quickly flooded the cofferdam. Of five men tending pumps and washing the foundation, two escaped. The three others were caught directly in front of the blow and were overcome.

Repairs to the dam were started immediately. The piles which had bent inward were pulled and new ones driven. T-piles were inserted in the new wall and an additional outside pocket constructed. The rest of the structure had not been damaged.

As a further precaution of safety permission was granted by the engineers to place under water enough concrete to seal the points of the piles in the northwest corner. The rock excavation having been previously completed, it was necessary only to clean up the loose material. Most of this was removed with a clamshell, and a diver with a jet washed the remainder down the slope. Panel forms of heavy timbers weighted with sandbags were framed and lowered into place in each bay of the timber bracing. Divers then lagged the 5-ft. openings between panels and sealed the bottom with sandbags. Concrete was carefully placed and allowed to set for ten days before the cofferdam was again unwatered. When the forms were removed, this concrete withstood inspection and proved to be satisfactory.

The last concrete was placed in the bottom of the south cofferdam on Dec. 15 and in the north one on March 8, 1928. The south pier was completed on March 28 and the north one on April 27, 1928.

Pulling Sheet Piling—Contrary to expectations, little trouble was encountered in pulling the sheet piling, though most of them pulled hard. The first, or key, pile in each pocket presented of course the greatest difficulty, being in tension along the vertical axis due to the weight of the backfill and presenting the maximum friction in both interlocks. This resistance increased in proportion to the length of the pile and was somewhat aggravated in this particular section for two reasons: First, because of the lighter section and its tendency to kink or distort, and second, because of the close-fitting interlock.

All piles in the south cofferdam were removed in full length. In the north cofferdam about two-thirds of the piles were pulled; the remainder were burned off at a depth of about 30 ft. below water. An inverted hammer with cable rigging was used successfully for the pulling handled both by land derricks and by derrick boats. An extractor designed for heavy pulling was also used.

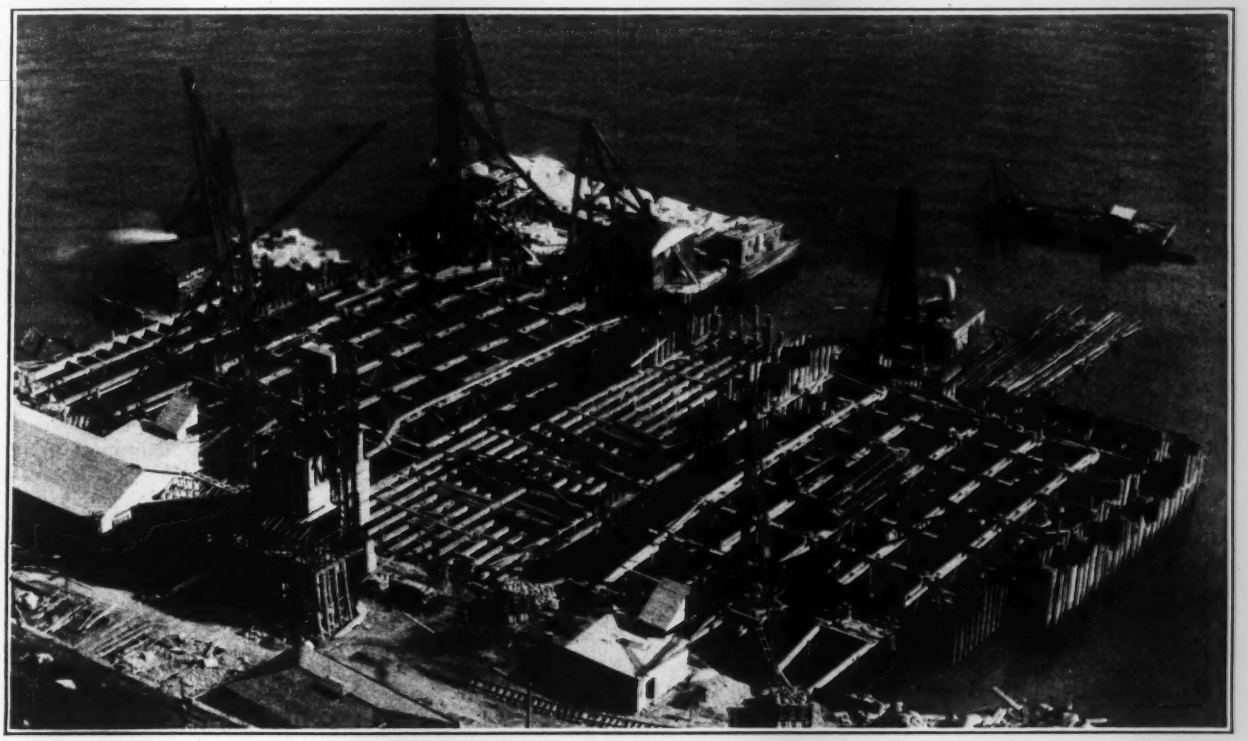


FIG. 7—COMPLETED COFFERDAMS—DREDGING OF POCKETS IN PROGRESS

Pressure Data—Some very interesting data were compiled concerning the actual stresses on different timber struts, calculated from measurements taken of deflection and of shortening under compression. These measurements were taken between copper tacks on each strut before and after unwatering the dam. The tacks were spaced about 30 ft. apart on a full-length timber, and all measurements were made very accurately with a steel tape, corrections being made for the temperature. The results of the data compiled showed that below the level of the submerged backfill the actual pressures were less than hydrostatic, while above this level they coincided with the hydrostatic pressure.

FIG. 8—RUGGED ROCK AT BOTTOMS OF PIERS

Construction Plant—The great size of the piers and the early date of completion demanded a construction plant of large capacity. Excavation within the cofferdams and the granite facing of the upper portions of the piers required heavy derrick equipment. With this equipment on hand and for economy and ease of handling concrete with a specified slump of 2 in., it was determined to place the concrete with 2-cu.yd. bottom dump buckets. A concrete plant consisting of a 2-cu.yd. mixer and a 150-cu.yd. storage bin with automatic weighing batchers was erected on shore midway between the cofferdams. A timber pier was built to fill the space between the cofferdams, and upon its outer end a stiff-leg derrick was erected. This derrick loaded sand and gravel with a clamshell from barges to a horizontal belt conveyor, which transported the material inshore to a vertical bucket elevator feeding the mixer bin. The plant is shown in Fig. 1.

Cement in bags was unloaded from barges on a belt running along the north side of the north cofferdam, carried inshore and dumped on a belt running toward the south through a long cement house, and up an incline to a head pulley on the mixer platform. The cement could thus be run direct from barge to mixer, or could be rehandled and stored in the house.

The concrete was handled in buckets hauled on a flat car by a gasoline locomotive on a track laid on the temporary center pier. Thence they were handled by two steel derricks, equipped with 125-ft booms, erected on pile foundations just west of each cofferdam. Ashlar stone was stored by courses in a yard at the south end of the work and rehandled by a heavy crawler crane.

All stationary plant, including the centrifugal pumps, was operated electrically, a power line being brought down over the Palisades.

The contract was executed under the direction of O. H. Ammann, chief engineer of bridges of the Port of New York Authority, Montgomery B. Case, engineer of construction, and F. E. Cudworth, resident engineer of the Hudson River bridge. Daniel E. Moran acted as consulting engineer on the foundations for the Port of New York Authority. The Silas Mason Company, Inc., of New York was the general contractor. Sub-contractors on the dredging and timber framing were the Morris & Cummings Dredging Company and the John C. Guise Company, respectively. The cofferdams were designed by Francis Donaldson, chief engineer for the contractors, and the work was performed under the supervision of H. L. Myer, resident manager. The writer was resident engineer for the contractors.

Spring Water Gravity Supply for Ada, Okla.

Flow Line 11 Miles Long Replaces Force Main and Water-Power Pumps—Covered Spring Basin and Reservoir

By N. T. Veach, Jr.
Black & Veach, Consulting Engineers, Kansas City, Mo.

A LARGE spring 12 miles from Ada, Okla., has supplied water to this city of 9,000 population for several years. A concrete curb wall around the spring itself and adjacent area forms an uncovered basin. The water flows by gravity about 4,000 ft. through a 36-in. concrete pipe line to a pump house, from which it is pumped through a 12-in. steel pipe line 11¼ miles to a concrete reservoir near the city, from which it is again pumped into the distributing system. As the collecting basin is uncovered, considerable trouble from algæ growths has occurred. Hydraulic-turbine-driven centrifugal pumps which force the water to the city consume approximately 70 per cent of the available supply, and on this basis the supply is rapidly becoming inadequate. The 12-in. pressure line, of uncoated steel pipe, has developed numerous leaks. The concrete reservoir has a wooden roof, in need of immediate attention. But the supply from the spring is of good quality, and a conservative estimate of the flow is something over 7 m.g.d., which will be ample until the city reaches a population of approximately 50,000.

Surveys showed that the supply could be conveyed to the city reservoir by a gravity conduit, eliminating the pumping station at the spring. It was therefore decided to improve the spring development, construct this flow line, cover the spring and construct a permanent cover on the reservoir, besides making extensive additions to the distribution system. This work is now under way. The improvement at the spring (Fig.1) will consist of

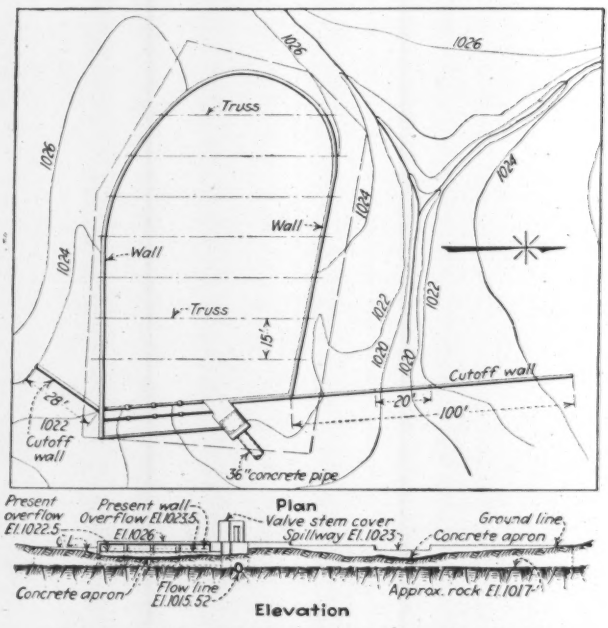


FIG. 1—SPRING COLLECTING BASIN, ADA, OKLA.

repairing and partly rebuilding the curb wall, covering the basin and constructing a concrete cutoff wall at the lower end of the development, extending far enough to intercept and divert the flow into the collecting basin.

A steel-frame roof over this basin is the most interesting feature in the work at the spring, the trusses being entirely above the roof to provide for proper maintenance without endangering the quality of the water. A thin concrete slab will be hung from the trusses at the panel joints, the only steel exposed to moisture being the bottom flanges of the channel purlins supporting the slab.

The new flow line will have a capacity of 7 m.g.d., and will be of 24-in. cast-iron pipe except for a short distance at the lower end, which will be 20 in. Leadite will

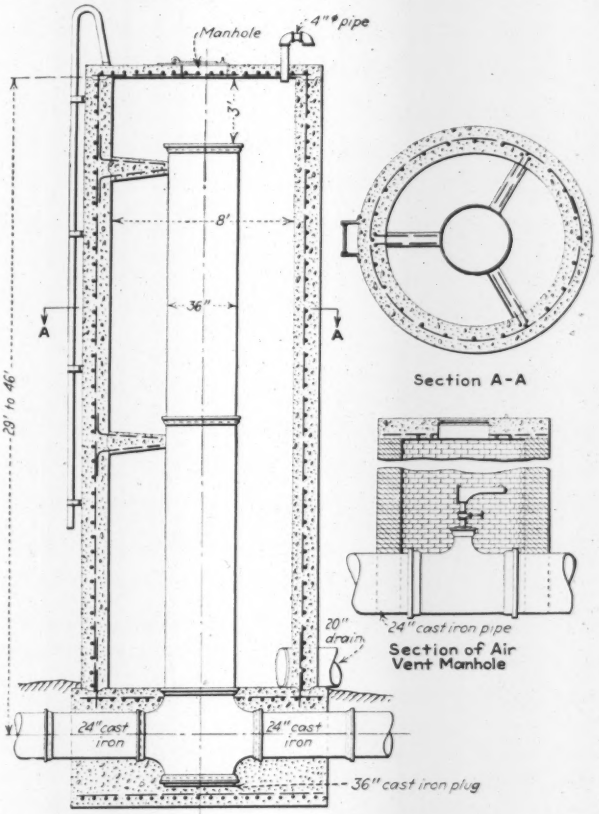


FIG. 2—SURGE CHAMBER ON PIPE LINE

be used for the joints. When subjected to the pressure test, the hydrostatic test heads will be 75, 130, 180 and 235 ft. for working pressure heads of 50, 100, 150 and 200 ft., respectively. The specified leakage test calls for a maintained pressure equal to the maximum hydraulic grade pressure under working conditions at the upper end of the test section, this pressure to be maintained for 48 hours, with an allowable leakage not to exceed 200 gal. per inch of nominal internal diameter per day per mile of pipe. Surge chambers and air relief valves will be provided, of the general design shown by Fig. 2.

Improvements at the city consist mainly of roofing the existing 2 m.g. concrete storage basin and building an overflow from this basin to an existing artificial lake. It is not planned to use control valves at the lower end of the line during normal operation, as the excess water would necessarily be wasted at either the upper or the lower end of the line, and by wasting it at the lower end a constant level can be maintained in the artificial lake, which is used for pleasure purposes. This plan can be followed as long as the supply from the spring exceeds the city demand. If it should be necessary to shut off the flow line near the lower end, arrangements will be made to close valves in the line near the surge chambers, allowing the water to waste through the surge chamber drains, thus releasing excessive static pressure below.

The storage basin already has a wooden roof. This

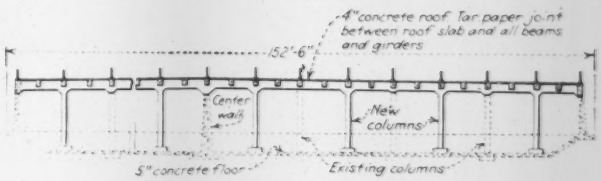

4" concrete roof. Tar paper joint between roof slab and all beams and girders
152'-6"
Center wall
New columns
5" concrete floor
Existing columns

FIG. 3—COVERED RESERVOIR

will be replaced by a 4-in. slab concrete roof, which necessitates putting in intermediate columns (Fig. 3).

Contracts for the flow line and additions to the distrbution system were awarded to the J. Randolph Contracting Company, Jacksonville, Fla., at $346,908; and for improvements at the spring and city plant to George M. Brown, McAlester, Okla., at $51,824. The engineering work, including supervision of construction, is being handled by Black & Veatch, consulting engineers, Kansas City, Mo.

Proposed Method of Design for Continuous Column Footings

Distribution of Bearing Areas by Bending Moments Figured by Simple Statics—Error in Using Three-Moment Equation Assumptions

By Norman B. Green
Structural Engineer, San Francisco

IN THE design of building foundations, the problem frequently arises of supporting columns at a property line so as to avoid eccentricity on the footing and at the same time not encroach on the adjoining property. This is generally accomplished either by combining the wall column and adjacent interior column on one footing or by placing all the wall columns on a single footing continuous along the property line. The accepted method of design for this latter type of footing is believed by the writer to be wrong in fundamental theory and to give results erring greatly on the side of danger.

A search in standard reference books shows a dearth of detailed design information on this particular problem, although a complete design appearing in Hool and Johnson's "Handbook of Building Construction" and a more general description appearing in a recent edition of "Concrete, Plain and Reinforced," by Taylor, Thompson and Smulski, is believed to represent standard practice. In this method the footing is considered to act as an ordinary continuous beam, the downward pressure of the columns representing the supports and the uniform upward earth pressure acting as the load. We are advised to use the same bending moment coefficients as for a floor beam, these to be reduced somewhat, if desired, on account of the smaller possibility for unbalanced loading. In the example of a design above referred to, the bending mo-

FIG. 1—REACTIONS AND BENDING MOMENTS FOR FOOTING CONSIDERED AS CONTINUOUS BEAM

ment at the center of interior spans and at interior supports is assumed to be $Wl/12$ and presumably the corresponding moments for an end span would be taken as $Wl/10$, although the design does not include an end panel.

The error in this method arises from assuming that the footing acts as a "continuous" beam, employing that term in accordance with its accepted usage. The use of the bending coefficients $\frac{1}{12}$ and $\frac{1}{10}$ involves the tacit assumption that the beam reactions are distributed in accordance with the equation of three moments. A little consideration will show that this is not the case. The column loads or "reactions" are of definite and predetermined magnitudes, and these depend in no way upon the elastic properties of the foundation beam. In other words, the beam stresses are entirely statically determinate regardless of the number of columns; the only assumptions necessary are that the earth pressure is uniform and that the columns rest on hinges.

A continuous beam of four equal spans l subjected to uniform load of total amount W on each span and with the reactions and bending moments indicated is shown in Fig. 1. Suppose that this beam is inverted and the reactions are represented by column loads. The intermediate column loads will probably be all equal, but the corner

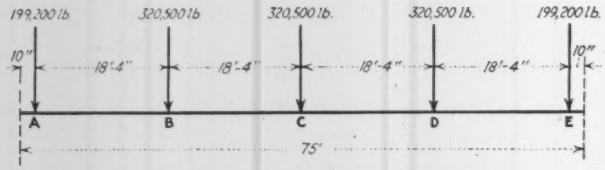


FIG. 2—CONTINUOUS FOOTING WITH FIVE LOADED COLUMNS

columns will carry considerably more than half that much, instead of less than half, as is required by the three-moment equation. The result is that all the positive moments will be greater and the negative moments less than those shown in Fig. 1.

As an actual example from practice consider five columns equally spaced and resting upon a continuous concrete footing as shown in Fig. 2. The column spacing is 18 ft. 4 in. and the center line of the corner columns lies 10 in. from the property line. The combined dead and live column loads are as indicated. Assuming that the beam is of uniform width, the net upward pressure per linear foot of foundation is 1,359,900 ÷ 75 = 18,100 lb.

With this value the bending moment at support C is, from statics: $M = 199{,}200 \times 36.67 + 320{,}500 \times 18.33 - 18{,}100 \times (37.5^2 \div 2) = +460{,}000$ ft.-lb. This moment appears in the second column of the accompanying table.

The moment under column B and the maximum moments in spans A-B and B-C are similarly computed and entered in the table. The second line of the table contains moments calculated by the use of coefficients $Wl/12$ and $Wl/10$. A comparison of the moments in the first and second lines of the table shows a very large discrepancy. For example, the maximum positive moment in span B-C is actually 1,155,000 ft.-lb., while the use of the continuous beams method gives only 506,000 ft.-lb.; also the sign of the moments at columns B and C by the usual method is actually the reverse of what it should be.

COMPARATIVE BENDING MOMENTS ON CONTINUOUS COLUMN FOOTING AS CALCULATED BY DIFFERENT METHODS

	B	C	A-B	B-C
Bending moments, from statics	+330,000	+460,000	+925,000	+1,155,000
Bending moments, using coef. $Wl/10$ and $Wl/12$	−608,000	−506,000	+608,000	+ 506,000
Bending moments, redistributed areas	−488,000	−700,000	+564,000	+ 140,000

If, as is generally the case, the foundation beam is made of uniform width, the proposed method of design would call for a beam of more than twice the moment of inertia required by the use of moment coefficients. How-

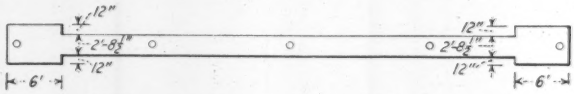


FIG. 3—COLUMN FOOTING WITH INCREASED AREA UNDER POINTS OF GREATEST BENDING MOMENT

ever, by employing a beam of varying width and by properly distributing the bearing areas, the bending moments in the first design can be cut down, so that the footing will cost about the same as that required by the second method.

Consideration of the moments appearing in the first line of the table shows that the bending moments are all positive. This condition is due to the fact that the corner column loads are too large in proportion to the intermediate column loads. Although we cannot decrease these column loads, we can accomplish the same effect by concentrating some of the bearing area at the two ends of the beam. This change gives us a footing of the form shown in plan in Fig. 3, where the total area is kept the same as before and the foundation pressure is 3 tons per square foot. The moments have been calculated for this footing, assuming a uniform soil pressure and employing the static theory. They are entered in the third line of the table and are seen to be fairly well equalized between positive and negative.

The proposed method of design for continuous footings is one of trial and error, the distribution of bearing areas being varied so as to adjust the bending moments to the desired values. In general the spreads should be kept as small as possible so that no lateral reinforcement is necessary. In some cases the spreads would have to be made entirely on one side of the beam, so as not to encroach on adjoining property. The eccentricity would then be taken out in the usual way by means of straps extending to interior columns.

Death Rate From Automobile Accidents

In the four-week period ended July 14, 1928, automobile accidents were responsible for 514 deaths in 77 large cities of the United States, according to figures reported by the Department of Commerce. This compares with 573 deaths in the corresponding four weeks of 1927. The following cities head the list, with the number of deaths noted: New York, 72; Chicago, 47; Detroit, 29; Cleveland, 22, and Philadelphia and Pittsburgh, 20 each. Six cities, Albany, Cambridge, Duluth, Jersey City, Louisville and Waterbury, report no deaths during the four-week period.

Sewerage System of Caracas, Venezuela

Design for Typical South American City as Worked Out by Its Own Engineers—Main Interceptor Along Guaire River and Branch Collectors, Twin and Single, Along Tributaries, With Cross-Sections for Present and Future Dry-Weather Flows and for Storm Flows

By Thorndike Saville

Professor of Hydraulic and Sanitary Engineering, University of North Carolina, Chapel Hill, N. C.

A Year's Leave of Absence from his university on the part of the author, under the conditions noted at the close of this article, was devoted in part to investigations of the sewerage system of Caracas. Such of the main features of the system, chiefly as designed by local engineers in the last ten years, as are of most interest to engineers in America and elsewhere throughout the world, are succinctly outlined. —Editor.

After one enters the principal port of Venezuela, La Guaira, located in about the center of the north coast, one passes in a southerly direction up the side of the coastal range of mountains. Just over the top of this range, in the valley of the Guaire River, lies Caracas, the capital of the country. The airline distance between the two cities is 8 miles, but the modern concrete road, itself a testimony to the progressive tendencies of President Gomez, is 28 miles long. Caracas is at an elevation of from 3,000 to 3,400 ft. and is almost entirely surrounded by mountains. The small Guaire River is the only natural outlet, and the city has been built along its banks. The present population of Caracas is about 135,000, and it is in most respects a quite modern city. In 1919, as the development of the country began to attract capital and foreigners to the city, the unsanitary conditions due to a lack of an adequate sewerage system demanded attention. As a consequence, a rather elaborate scheme for the construction of a complete sewerage system was approved and has been in process of execution ever since.

A description of this system, with comments on its functioning, may interest readers of *Engineering News-Record* as indicating methods of sewer design developed for a typical South American city by its own engineers, especially as these methods vary from practice in this country. The Venezuelan engineers have been governed chiefly by French practice, and it is only recently that the precepts of the treatise of Metcalf and Eddy have modified ideas in accordance with American methods. No foreign engineer has been connected with the design or construction of the present system.

The general plan for the new sewerage system adopted in 1919 consisted of the following basic elements: (1) Adoption of the combined system. (2) Construction of a main interceptor or collector along the north bank of the Guaire River (nearly all the population being north of the river). (3) Construction of secondary collectors along each bank of the principal tributaries of the Guaire —the Caroata, Catuche and Anauco creeks — and a single secondary collector in the bed of each of the smaller creeks, notably Cienfuegos and Matadaro. Each of these collectors discharges into the main interceptor. (4) Construction of stormwater overflow openings in all collectors to keep their size within moderate limits. (5) Connection of existing and new street sewers (either circular or ovoidal) to the secondary collectors.

The combined system was decided upon for two reasons: (1) Houses of Caracas, as in most Latin American countries, are built about a patio or central courtyard which is open. The roofs drain for the most part toward this court and the rainwater is conducted to the main house sewer, which passes beneath the surface of the court. Ordinarily there is a trapped surface drain connecting with this sewer at one or more parts of the court, which disposes of rainfall falling directly on the court. In consequence, it would involve a great expense if all existing houses had to divert stormwater into a separate sewerage system, and would in fact be impracticable to accomplish in the more congested parts of the city. (2) The portion of the city represented by streets and roofs draining toward streets is estimated at only 20 per cent of the total area, and on account of the steep grades prevailing generally in the built-up portions of the city, combined sewers require only a small extra diameter to care for this additional drainage, which might otherwise be disposed of separately. Furthermore, the size of the collectors is kept within limits by providing overflow openings for excessive storm discharge.

The system as constructed has not served satisfactorily to care for the heavy precipitation falling during severe showers in the rainy season. Streets, particularly in the lower parts of the city, are frequently inundated with 2 to 4 in. of water, which rushes down the steep pave-

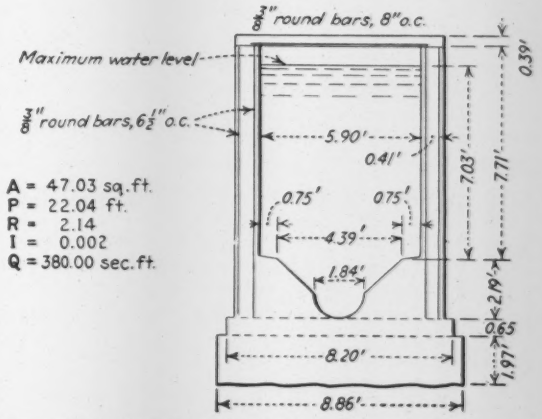


FIG. 1—STANDARD SECTION FOR MAIN COLLECTING SEWER, CARACAS, VENEZUELA

The semicircular channel is designed to carry the present normal dry-weather flow, estimated as 40 g.d. (150 liters) per capita. The trapezoidal section, with three times the capacity of the semicircular, is intended to serve an increase in population and water consumption. The upper rectangular portion is for storm flows. Slopes are provided to give flowing full velocities in the semicircular sections of from 2.95 ft. per second for the smaller to 1.97 for the larger sections. The section here shown is the maximum, on the main or Guaire River collector.

ments from the higher elevations. Efforts have been made to place gratings connecting with the sewers or creeks extending across the entire width of steeply sloping streets, but these have been only moderately effective. Where the steep unpaved streets lead into main paved thoroughfares, the detritus carried into the paved streets after a heavy storm is often sufficient to interrupt street-car traffic. This condition is due (1) to partial incompletion of the street sewers in parts of the city, and (2) to inadequate design of the system to remove water from the streets. As a consequence, during 1927, the combined system was modified in many cases, especially in the newer portions of the city toward the east, and separate storm sewers are being constructed to discharge directly into near-by creeks.

All of the main and secondary collectors thus far built have been designed upon the combined system. (See Fig. 1 for standard cross-section; also explanatory

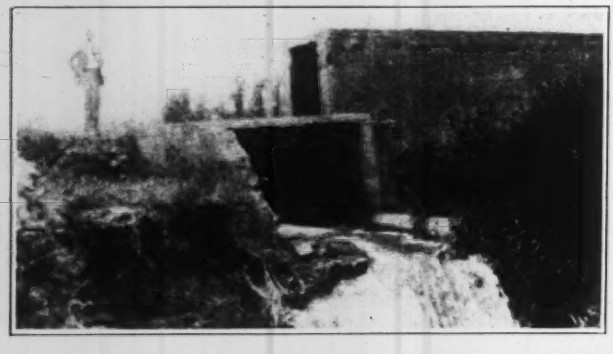


FIG. 2—OVERFLOW AT JUNCTION OF CATUCHE AND MAIN COLLECTOR
At present the main collector ends and discharges at this point.

sub-title regarding the section and the slopes.) Tables have been prepared based on number of persons tributary which give the minimum slope necessary to produce the required velocity. The use of these tables frequently results in overdesign, since the actual slope is nearly always considerably greater than the minimum required. This introduces a slight factor of safety which is often greatly needed. Tables are also provided giving the dimensions of the required trapezoid when the diameter of the semi-circular section has been determined.

In practice, the functioning of the collectors does not entirely fulfill the conditions proposed, both because no account was taken of diurnal variations in flow and because estimates of normal low flow were too low. As a result, in some of the collectors the trapezoidal section is already flowing full during a portion of the day. This is not a serious matter, since ample capacity remains in still a third section, which is rectangular, constructed above the trapezoidal section and designed to care only for storm flows. These flows are based upon an assumed maximum rainfall of 9 cm. (3.55 in.) per hour. It is considered that the time of concentration is double the period of rainfall and hence the section is designed to carry 1.785 sec.-ft. per acre (125 liters per hectare). No consideration was given to the duration of the rate of rainfall used, or of any other rate, and no data of this sort existed at the time the designs were accepted, and the given rate has been applied to rainfalls of one minute and one hour duration. (The bases of design of the sewers are set forth in detail in the Memorias de Obras Publicas for 1922.) In consequence, the estimated rate of flow of 125 liters per second has in many instances been found too small in practice, especially from the smaller drainage areas.

In 1926, Señor Felix Aguerrevere assembled data from observations on intense rainfalls collected at stations equipped with non-recording gages from 1901 to 1920, and at one station equipped with a recording gage (by a prominent engineer, Dr. Ricardo Zuloaga) from 1921 to 1922. As a result he developed a curve of maximum rainfall intensity represented by the formula $i = 224 \div (t + 64)$ in. per hour, where t = duration in minutes. The formula was recommended for use between periods of eight minutes and 2½ hours. The modified present design of storm sewers has been increased to 2.86 sec.-ft. per acre (200 liters per second-hectare). Using the local factor of 0.8 as a coefficient of runoff and 0.5 as coefficient for time of concentration, we get an intensity of 7.16 sec.-ft. per acre or 7.08 inches per hour (18 cm. per hour), which cannot occur by Aguerrevere's formula. Although the formula is based upon determining points not obtained by recording gage records and although the enveloping curve of extreme rainfall does not include a record of 9.65 cm. (3.8 in.) in 25 minutes, or a rate of 23.16 cm. (9.12 in.) per hour, that fell during an extraordinary rainfall in October, 1878, nevertheless Aguerrevere has no doubt suggested a much better basis of design than the empirical assumptions used. By use of the formula it is clear that the assumption that time of flow to sewers is always double that of the period of rainfall is markedly in error, and that actual time of flow is much less than this. In an example

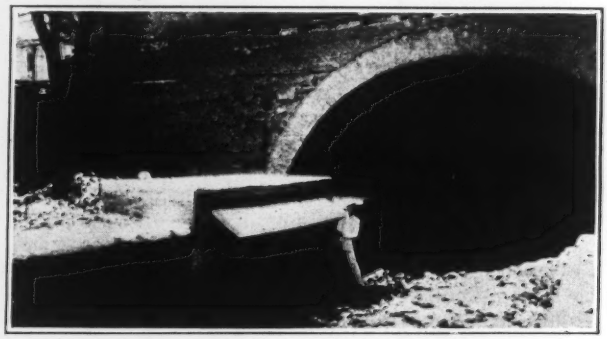


FIG. 3—OVERFLOW WEIR IN SIDE WALL OF COLLECTOR
An iron door is swung outward by the pressure of the stormwater. This view also shows one of the main cases where a collector passes beneath a bridge. In other cases there are two such collectors, one on either side of the stream.

of the use of his formula, Aguerrevere has assumed 3½ minutes as the time for a ten-minute rainfall of 7.7 cm. (3.4 in.) to reach the sewer. It appears probable, however, that the assumptions as to total flow used in the design of the sewers are reasonably adequate, due not to the correctness of the underlying basic data but to observation of actual flows.

In developing tables to facilitate calculations of the various parts of these standard sections, use is made of the advantage inherent in the metric system, whereby slope may be expressed as a whole number. Thus a slope of 0.001 may also be expressed as 1 (millimeter per meter), and the tables are all based on a slope of unity. Hence to obtain the dimensions required to care for any given flow, it is necessary only to divide the discharge by the square root of the slope expressed as a whole number and enter the table with this discharge for slope of unity to find the required standard dimensions.

The secondary collectors pass under many bridges. It became necessary in each such case to be certain that sufficient waterway was left after the collectors were built to carry floodwaters arising above the upper ends of the collectors, which are carried upstream on each creek only within the inhabited portions of the creek. For determining the area required to be left under bridges, the formula $V = \sqrt{3RI}$ in metric units is used, which is about equivalent to $V = 100\sqrt{RS}$ in English units. This formula will apply reasonably accurately if R is less than 1, assuming $n = 0.013$. Since only four out of fourteen bridges have R much greater than 1, a safe design has resulted, especially as the bridge sections in all but one case were much greater than required. In this one case the bridge was reconstructed to provide a greater waterway.

Mention has been made of the provision for overflow in the collectors to relieve them of excessive stormwater flow and keep the size within reasonable limits. The basis for determining at what point overflow was permissible rests upon a total flow in the sewer at least ten times the estimated maximum dry-weather flow. Beyond this discharge overflow was permitted, and further dilution would of course occur in the stream. The slopes being great, no objectionable condition was anticipated, and none has arisen from this cause.

When possible, overflow is made to occur at junctions of collectors by building one collector at such an elevation that the excess stormwater will pass over the top of the other collector into which the first collector discharges. This method is shown by Fig. 2.

At times this simple provision for overflow has not been possible, and longitudinal weirs have been constructed in the side walls of the collectors (Fig. 3). The calculation of the dimensions of these overflow weirs has been arrived at by developing a formula by rigorous mathematical methods, since the methods outlined in the treatise by Metcalf and Eddy were considered too cumbersome to apply, as were other methods described. However, the mathematical method developed requires far greater time than methods previously used, and is at best an approximation, as are the other methods.

Naturally, the construction of the main interceptor along the north bank of the Guaire River has been the work of greatest magnitude in carrying out the sewerage scheme adopted. The form of the collector changes due (1) to increased capacity after entrance of lateral collectors, (2) to decreased capacity required after overflow weirs and (3) to necessity for joining the modern sections with an earlier ovoidal section still capable of serving. The main collector crosses all creeks except two by means of reinforced-concrete slab bridges supported by concrete trestles. In the crossing of the Caroata and Catuche creeks siphons are to be used.

The Caroata siphon has been constructed. It consists (Fig. 4) of two 1-m. (3.28 ft.) circular concrete pipes beneath the creek, joining chambers on each end of the siphon which connect with standard sections. The design velocities (which did not consider losses at entrance or exit) were 2.9 ft. per second during maximum discharge and 0.07 ft. per second during normal dry-weather flow. There is no provision for cleaning either of the tubes nor for using one only for carrying low-water flow. Both are in service all the time, and, as may be imagined, silting has occurred to such an extent that at times the siphons do not function at all, but sewage backs up and is discharged from the overflow shown in the right lateral Caroata collector. Large quantities of silt also deposit in the settling basin at the entrance of the siphon. Due to the difficulties with this siphon, it is proposed to construct the Catuche siphon of five pipes, of which two will be 0.5 m. (1.64 ft.) and three of 1 m. (3.28 ft.) in diameter, with weirs so located in the entrance chamber that the present dry-weather flow will pass through one of the small tubes and the three large tubes will come into service one after the other as storm flows of increasing magnitude occur. The second small tube is to be reserved for future increase in dry-weather flow.

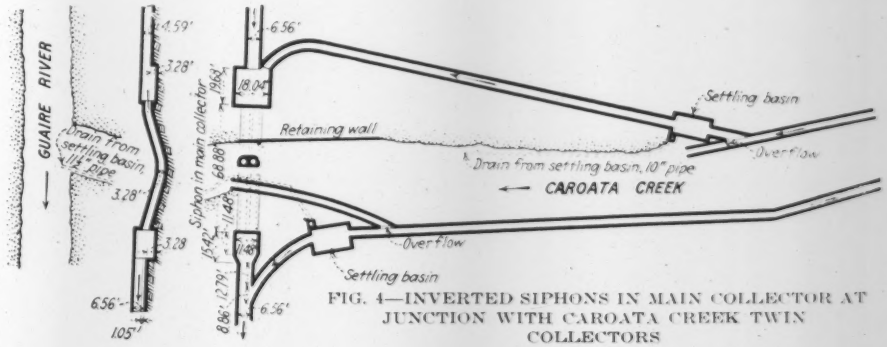


FIG. 4—INVERTED SIPHONS IN MAIN COLLECTOR AT JUNCTION WITH CAROATA CREEK TWIN COLLECTORS

For the larger sewers in the principal streets an egg-shaped section has been used, and where large quantities of stormwater have to be handled two such sewers are laid side by side. The standard dimensions range from approximately 8x12 in. to 39x59 in. There is a strong tendency to displace the use of rectangular sections with the egg-shaped section whenever possible. The smaller sewers are circular and range from approximately 8 to 24 in. in diameter. Elaborate tables and diagrams for calculating the dimensions and size to use have been prepared. The pipes are made of concrete by hand packing in steel molds. No machinery, not even a concrete mixer, is used in the manufacture of these pipes. No terra cotta pipe is used.

During the past few years a considerable area south of the Guaire River has been built up with many costly residences. This region, called El Paraiso, is the most beautiful residential part of Caracas. Sewers have been laid, but at such an elevation that they cannot enter the main interceptor on the opposite side of the river at present, and no immediate plans are in prospect for remedying the situation.

There are areas above the beginning of the Guaire collector like the Paraiso district, discharge sewage directly to the river. Hence, although conditions in the river have been vastly improved by work already accomplished, much still remains to be done before the river may be considered unobjectionable from a sanitary or nuisance standpoint in its course through the city. The main collector will eventually carry the sewage a short distance below the city and then discharge it to the river. The river is, and will remain, badly polluted below the

city until all the sewage which now discharges into the stream is collected and a form of sewage treatment is provided which will suit local conditions.

The flow of the river below the city during dry periods is almost wholly composed of sewage, and as the inhabitants of towns farther downstream take water for domestic purposes from the river during periods of excessive drought, much intestinal illness occurs. The writer was called upon to make some studies relative to the pollution of the river, and found conditions to be extremely bad. The relative stability was zero (even during normal stream flow) and the biochemical oxygen demand 220 p.p.m. The dissolved oxygen at a point immediately below the sewer outfall was 2.05 p.p.m. and at a distance of 1 mile farther downstream was zero. Works for the treatment of sewage are manifestly needed. The writer recommended that an experimental treatment plant be constructed to determine the best method to pursue under the conditions of climate and character of sewage found in Caracas. Local engineers have recommended large septic tanks. In the opinion of the writer it is probable that Imhoff tanks and sprinkling filters would be most satisfactory. It is improbable that an activated-sludge plant would receive proper operation even in conditions otherwise pointed to its adoption. The region about Caracas is highly agricultural, and sludge from an Imhoff tank unit (or possibly preferably an installation for plain sedimentation with separate sludge digestion) would prove satisfactory and would bring support to the project from the influential owners of neighboring haciendas.

The sewerage system has cost in the neighborhood of $1,500,000, and has been carried on over a period since 1920. Engineers are paid from $1,500 to $2,400 per year with perquisites. The latter enable those in the higher ranks to live very well indeed.

The writer was concerned with investigations of the sewerage system during a year's leave of absence which he spent mostly in Venezuela with the International Health Board of the Rockefeller Foundation as chief engineer of the Sanidad Nacional. He is indebted to the present Minister of Public Works, Dr. José Ignacio Cardenas, for providing many courtesies which made possible this article. A thorough review of the past practice in designing the sewerage system is now being carried out under the direction of Dr. Cardenas, to determine if the combined system shall be continued, or (as has already begun to be the case in parts of the city) be changed where practicable to the separate system with storm and sanitary sewers.

The writer acknowledges also courtesies extended by Dr. Jorge Rivas, director of statistics in the Department of Public Works, and by C. E. de la Madriz, an engineer of the department formerly in charge of much of the sewer construction. Mr. de la Madriz had devised an interesting method of bonuses and penalties applied to wages of laborers on construction. F. M. Bell, now fellow at the Engineering School of the University of North Carolina, was the writer's principal assistant during his investigations in Venezuela.

The extensive public-works program of Venezuela, of which the Caracas sewerage system is a part, has been one of the major projects in the intensive development of the country under the régime of President José Vicente Gomez, who has pursued for many years a policy designed greatly to improve the financial and living conditions in the larger cities of the country.

Automatic Constant-Temperature Bath for Asphalt Tests

Electrically Controlled Circulating Water Bath Keeps Specimens at Temperature Varying Only One-Tenth Degree

By C. W. Betz

Chief Chemist, Bureau of Tests and Specifications, Allegheny County, Pittsburgh, Pa.

REGULATION of the temperature of a water bath has always been a problem and a source of annoyance in laboratories where asphalts and road materials are examined as a routine procedure. An automatic electrically controlled circulating system in use in the laboratories of the Bureau of Tests and Specifications, County of Allegheny, Pittsburgh, Pa., for four years has given efficient and satisfactory service, regulating the temperature of the water to within 0.1 deg. C. The system is

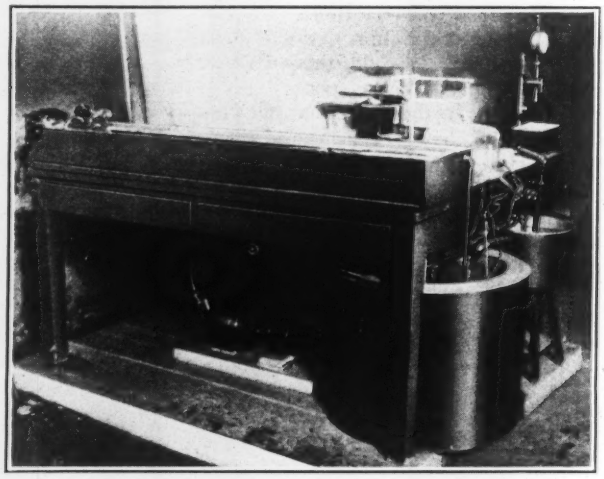


FIG. 1—CONSTANT TEMPERATURE WATER BATH AS SET UP IN LABORATORY

simple in construction and operation. Practically all of it is home-made, it having been built in our own laboratory and shop.

The system (Figs. 1 and 3) consists of a large double-walled circular tank containing the general water supply, wherein are placed the thermostat and source of heat. From this tank the water is pumped by separate pipes respectively to the ductility machine, the tank beneath the penetrometer and the sample storage tank. The water is also pumped directly back into the main tank—that is, the water is taken out at the bottom and directly put in at the top. This gives a more effective circulation within the main water supply and no agitator has been found necessary. All supply pipes are controlled by valves so that water may be pumped into all tanks at once or into any tank separately. A check valve may be placed in the pipe leading to the ductility tank to prevent water running back into the main tank and overflowing when the pump is shut off and the closing of the hand valve is neglected. The ductility tank overflows into the main tank. The penetrometer tank overflows into the sample storage tank, which in turns overflows into the main tank. The main tank may be connected to the water mains as a

convenient method of filling the system or of replacing loss by evaporation.

The pump used is a small, simple type of rotary pump operated by a ¼-hp. electric motor.

In order to maintain a uniform temperature in the ductility tank the water is introduced by means of a perforated pipe, capped at the end, lying on the bottom of the tank and running its entire length. The holes increase in size toward the capped end of the pipe.

The thermostat used to control the temperature is as illustrated (Fig. 2), the capillary filled with mercury and the bulb filled with toluene. The heat is supplied by means of one or more 200-watt lamps operated at 110 volts through a small relay. The thermostat circuit is stepped down by means of a bell-ringing transformer. The relay used in this laboratory is of the mercury contact type, although an ordinary telegraph relay is satisfactory.

This system, we find, will maintain the temperature of the water to plus or minus 0.1 deg. C. There is a slight lag in the temperature of the storage and ductility tank and the temperature in the main tank must be kept slightly higher than that desired. This must be determined by experiment and the thermostat regulated accordingly. Covers are provided for the ductility and storage tank and at least half of the main tank, thus keeping the heat loss as low as possible. Thermometers graduated to 0.1 deg. C. are hung in the storage tank and supply tank.

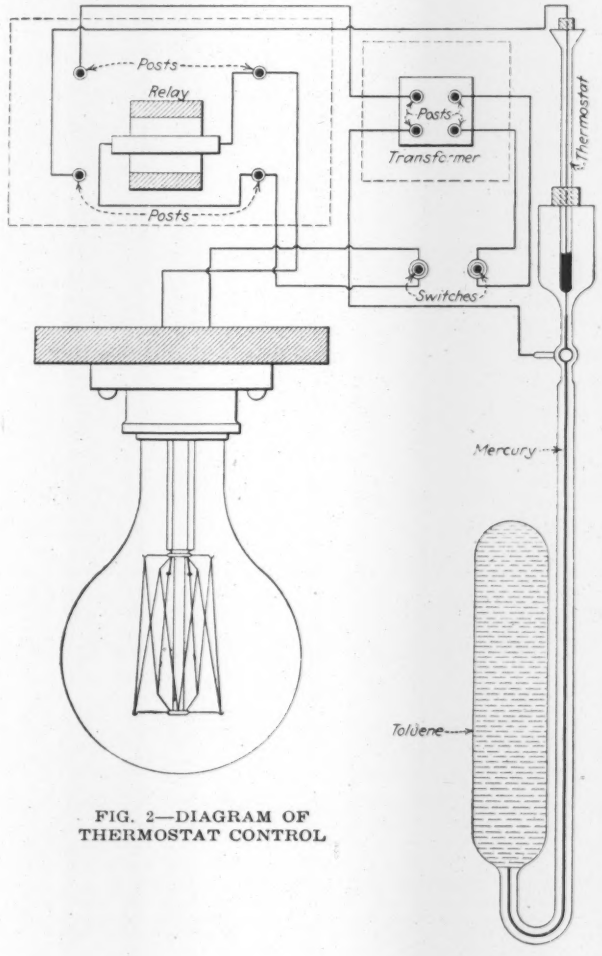


FIG. 2—DIAGRAM OF THERMOSTAT CONTROL

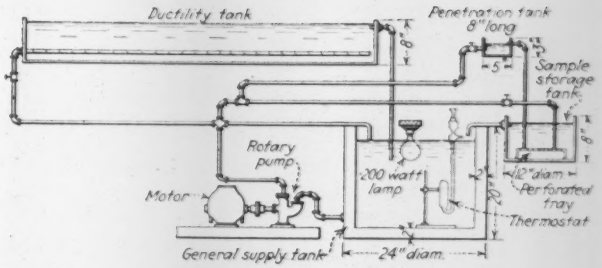


FIG. 3—SCHEMATIC DIAGRAM OF CIRCULATING WATER BATH

The system is operated continuously, thus always assuring water of the required temperature, usually 25 deg. C. The pump may be shut off at night, but the thermostat will maintain most of the water in the supply tank at the proper temperature and the whole system rapidly regulates itself after the pump is turned on in the morning. Both penetration and ductility samples are placed in the sample storage tank for the required length of time. The sample for penetration is then immediately transferred to the small penetration tank for the determination. If the room is exceptionally cold, the ductility tank may be slightly under temperature, but the addition of a small amount of hot water quickly remedies this immediately before the run.

Foundry Inspection of Pipe Pays

By W. C. Hawley

Chief Engineer and General Superintendent, Pennsylvania Water Company, Wilkinsburg, Pa.

AMONG water-works engineers the practice of requiring all cast-iron pipe to be inspected at the foundry before it is coated is becoming quite general, though there are still some who do not believe that it pays. It may be interesting, therefore, to note that a recent check-up on breaks with the foremen in charge of the distribution system of our company showed that inspection is worth much more than it costs.

Prior to 1902 the pipe which went into our distribution system was purchased without inspection. Since that time all pipe has been inspected. Possibly two-thirds of the 210 miles of pipe now in the system was inspected when purchased. It has been noted that practically all of the breaks in recent years have been in pipe that was purchased without inspection. These have been due mostly to cold shuts, sand or air holes, core out of center, etc., all of which would have been eliminated by proper inspection. The damage to property, pavements and the cost of making repairs to the breaks in uninspected pipe have amounted to many times what it would have cost to inspect the pipe in the first place.

To these costs must be added the losses due to interruption of service, the irritation of consumers whose water supply is necessarily shut off for hours while repairs are being made and, last but not least, the ill will of the municipal authorities when traffic is interfered with and pavements are damaged.

Our only breaks in inspected pipe have been square breaks in 4- or 6-in. pipe which were due probably either to heavy traffic or to failure properly to tamp backfill under and about pipe, or else were due to settlement caused by the digging of a sewer or other trench deeper than the water pipe.

Strain Effects in Mild Steel

Present Scientific Knowledge of "Strain Workings" or Lüders Lines as Related to Incipient Yield and Plastic Flow Is Summarized and Methods of Observing Such Markings Are Outlined, With Notes on the Hardening and Increase of Corrodibility of Steel by Strain, and on Neumann Lines

By Henry S. Rawdon
Senior Metallurgist, Bureau of Standards, Washington, D. C.

How to detect the existence of permanent strain in metals is of considerable interest and often of decided importance to engineers. The term "permanent strain" necessarily implies a yielding of the metal of a structural member under the stress imposed upon it. So long as the metal behaves elastically under stress—that is, so long as the direct proportionality between stress and strain is not disturbed—no record remains to indicate either the magnitude or the distribution of a stress after this has been removed. If the stress is great enough, however, the material is permanently affected and the resulting change in the structure of the metal serves as a record of the previous treatment of the material.

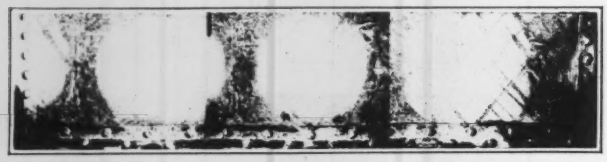


FIG. 1—STRAIN MARKINGS DEVELOPED IN A STEEL COLUMN

From Bureau of Standards Technologic Paper 327, by R. S. Johnston. The surface, which was covered with mill-scale, was whitewashed with cement wash to secure good contrast when flaking of the oxide in the strain markings occurred. The specimen was a full-size tower web section of the Delaware River bridge, of silicon-manganese steel (C, 0.33 per cent; Mn, 0.94 per cent; Si, 0.33 per cent).

One of the most important points in connection with the permanent straining of metals, at least in the initial stages—for example, during the "yielding" of mild steel—is the fact that this effect is usually quite local in character instead of being distributed uniformly throughout the strained member. It is this localization of the effect which constitutes, in large measure, the record of the change which has been brought about in the material.

Iron is the metal which shows this phenomenon best, and nearly all of the studies that have been made along this line have been on low-carbon and mild steels. This is of especial interest to engineers, since steel of this kind enters so widely into engineering work. The discussion which follows relates to this class of material.

Mechanism of Straining—The mode of deformation of any metal under stress is intimately related to and, in fact, is determined by the structure of the metal. The fact that from the structural point of view every metal is an aggregate of microscopic crystalline grains is so well established that further emphasis here on this point is unnecessary. These grains, except in very brittle metals or alloys, are capable of a change of form when stressed sufficiently, the change being brought about by minute *slipping of parallel layers* within the crystal, along definite crystallographic planes. Within any grain there are certain crystallographic planes of easy slip, this condition being dependent upon the crystal habit of the metal. Deformation or slip occurs most readily within any grain when the imposed stress acts along the planes of easy slip. The summation of the minute slippages occurring within a great number of the grains constitutes the visible elongation, or other deformation, which is measured on a test specimen—for example, a tension specimen.

The effect of stress on the structure of mild steel and the various methods for detecting strain-effects are most conveniently considered by reference to the curve summarizing the behavior of this material when stressed in tension. It should be borne in mind that the properties of any metal, as ordinarily determined, are those of an aggregate of grains, and not those of the individual grains. The properties of a single crystal (that is, a grain) of iron are distinctly different from those of the aggregate of which the grains form the units. In most respects the tensile properties of the single grains are lower than the corresponding properties of the aggregate. Particularly is this true for the elastic properties of the metal.

Elastic Deformation—So long as the proportional limit of the metal is not exceeded when the material is stressed, the structure of mild steel is not changed, at least not to an extent that the microstructure, after the load has been removed, is visibly affected.

Lester and Aborn ("The Behavior Under Stress of the Iron Crystals in Steel," *Army Ordnance*, Vol. 6, p. 120, 1925), have observed irregularities in the behavior of some of the crystal grains in steel when the material was stressed within the elastic range (of the aggregate),

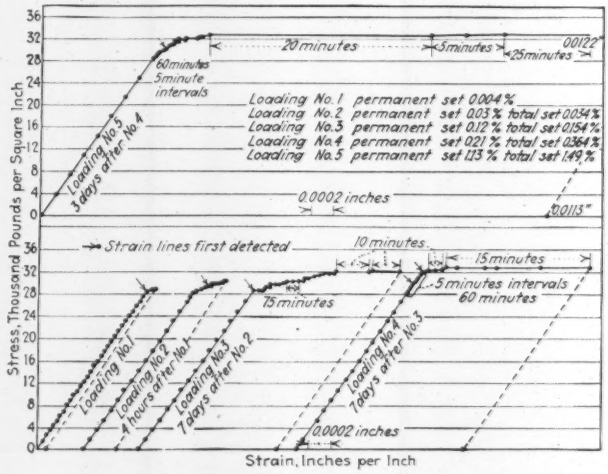

Stress, Thousand Pounds per Square Inch
Strain, Inches per Inch
20 minutes
5 minutes
25 minutes
0.0122"
60 minutes 5 minute intervals
Loading No. 1 permanent set 0.004%
Loading No. 2 permanent set 0.03% total set 0.054%
Loading No. 3 permanent set 0.12% total set 0.154%
Loading No. 4 permanent set 0.21% total set 0.364%
Loading No. 5 permanent set 1.13% total set 1.49%
Loading No. 5 3 days after No. 4
0.0002 inches
0.0113"
Strain lines first detected
10 minutes
15 minutes
5 minutes intervals
60 minutes
15 minutes
Loading No. 1
Loading No. 2 4 hours after No. 1
Loading No. 3 7 days after No. 2
Loading No. 4
Loading No. 5 7 days after No. 3
0.0002 inches

FIG. 2—STRESS-STRAIN CURVES OF MILD STEEL STRESSED REPEATEDLY IN TENSION

The formation of the strain markings coincides with the yielding of the material, and for this material agrees fairly well with the proportional limit; composition of the steel was C, 0.17 per cent; Mn, 0.40 per cent

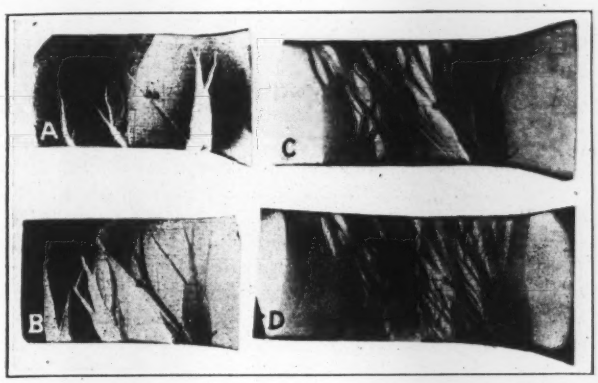


FIG. 3—STRAIN MARKINGS ON A TENSION SPECIMEN
The part shown is one end of the reduced section of a specimen of Fig. 2.

which they have explained as indicating slight slip within the grains. The deformation is not great enough, however, to show in the microstructure of the material.

Strain Effects Accompanying Yielding—The strain effects which accompany the yielding of mild steel will be referred to here as "initial strain effects" in contradistinction to the effects which occur as the material is plastically deformed when the stress is increased above that corresponding to the yield point. The latter effect, which is progressively more and more severe and culminates in the fracturing of the specimen, is much more pronounced than the initial strain effect and may well be referred to by the term cold working.

A knowledge of the initial strain effects, the means for revealing them and their possible influence on other properties of the metal is much more valuable to engineers, as a rule, than a consideration of the more severe strain effects of plastic deformation or cold working, since the former often constitutes the first clear indication that the factor of safety for any given structure has been exceeded.

Surface strain markings have long been of interest to engineers and metallurgists. As early as 1836, Piobert observed peculiar markings on metal parts of guns after service. (*Memorial de l'Artillerie*, Vol. 5, p. 505, 1926. See also C. Fremont "La Cause de la Formation du Palier dans l'Essai de Traction des Aciers Doux," *Genie Civil*, Vol. 82, p. 176, 1923.) About twenty years later similar observations were made by Lüders, and the phenomenon is usually referred to by his name, though often coupled with that of Hartmann, who, considerably later, studied the phenomenon in considerable detail. (See W. Lüders, "Ueber die Aeusserung der Elasticität an Stahlartigen Eisenstäben and Stahlstäben," *Dingler's Pol. Jour.*, Vol. 155, p. 18, 1860; and L. Hartmann, "Sur la distribution des déformations dans les métaux soumis à des efforts," *Comptes rendus*, Vol. 118, p. 520.)

Fig. 1 shows strain markings of this kind developed on the face of a steel column by subjecting it to compression. This column was one of a series built especially for test purposes and intended as representative of those used in the construction of the Delaware River bridge. (R. S. Johnston, "Compressive Strength of Column Web Plates and Wide-Web Columns," Bureau of Standards Technologic Paper 327, 1926). The fact that the strain was not uniformly distributed throughout the entire structural member when stressed in this manner is very evident. Those portions to which the yielding of the metal under stress was confined have been clearly revealed by the flaking of the surface oxide coating (mill scale) on the steel, together with the whitewash coating of portland cement in water which was applied over the oxide coating in order to increase the contrast between the flaked and the unflaked areas and thus delineate the strain markings more clearly for photographic purposes.

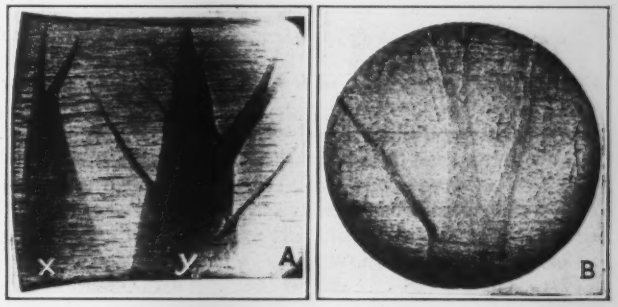


FIG. 5—SURFACE APPEARANCE OF THE STRAIN MARKINGS ON SOFT STEEL
In left-hand view the line *x* formed at 28,600 lb./in.²; line *y* at 30,200 lb./in.²; the load was held constant ten minutes and the wedges widened to the extent shown; the 45 deg. branches formed at 32,000 lb./in.² Magnification, 2.
The right-hand view shows part of the specimen B of Fig. 3. These markings were formed during loading No. 2, Fig. 2. Magnification, 3½.
Note the rippled surface within the strain markings, indicating the yielding of the metal.

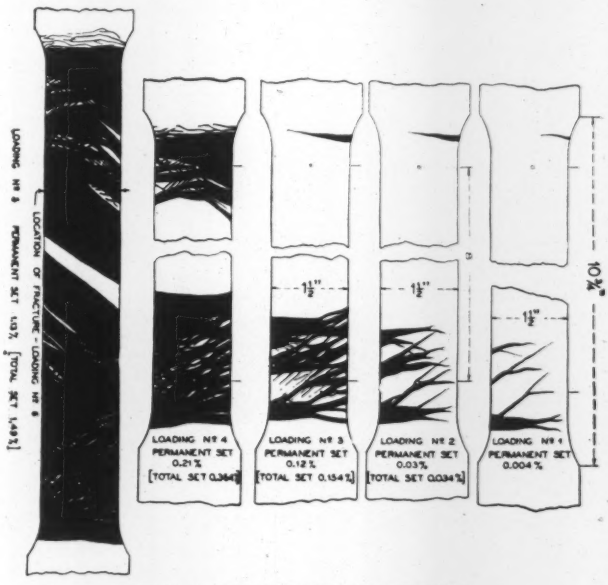

LOCATION OF FRACTURE - LOADING Nº 5
LOADING Nº 4 PERMANENT SET 0.21 % [TOTAL SET 0.36%]
LOADING Nº 3 PERMANENT SET 0.12 % [TOTAL SET 0.15%]
LOADING Nº 2 PERMANENT SET 0.03% [TOTAL SET 0.03%]
LOADING Nº 1 PERMANENT SET 0.004 %
1½"
10"

FIG. 4—PROGRESSIVE YIELDING
Tension specimen loaded several times in succession; compare Fig. 2.

Observations made in this manner are most valuable in a qualitative way for demonstrating the variations in the distribution of the strain effect in a member which has yielded under load. In order to obtain reliable indications of the stress at which yielding occurred it is better to rely upon observations made on the polished surface of a test bar as it is subjected to a progressively increasing load. A determination of the yield point in tension of mild steel made in this way, as shown in Fig. 2, corresponded very closely to the proportional limit of the same material as determined by strain measurements made with a Ewing extensometer. The surface strain markings produced at one end of the specimen as it was repeatedly loaded are illustrated in Fig. 3, while Fig. 4 summarizes

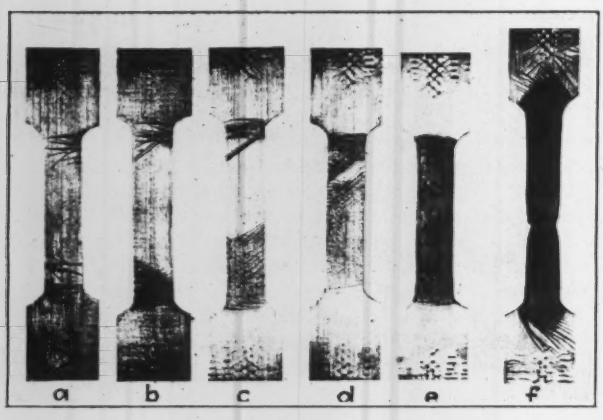


FIG. 6—STEEL SPECIMENS STRESSED IN TENSION TO DIFFERENT DEGREES AND ETCHED

Acidified copper solution (Fry's reagent) used to show the strain distribution. (J. D. Jevons, *Jour. Iron & Steel Inst.*, Vol. 111, 1925). The specimens were of 8-in. gage length; they were strained and then machined smooth before etching. (*a*) "yield point"; (*b*) 0.5 per cent elongation; (*c*) 1 per cent elongation; (*d*) 2 per cent elongation; (*e*) 4 per cent elongation; (*f*) broken at 29 per cent elongation.

these markings for the entire specimen and shows how the strain effect or "yielding" progressed throughout the specimen from both ends as the loading was continued.

It will be seen from these illustrations that the first evidence of permanent strain or yielding in a specimen stressed in tension appears at the ends of the reduced section close to the fillet. This might be predicted, since, as can be shown by stress analysis by the optical method, (E. G. Coker, "Photo-elastic Methods of Testing," *Report* of British Asso. Advancement of Science, Vol. 92, p. 313, 1924; also E. G. Coker, "Photo-elasticity for Engineers," *Gen. Elec. Rev.*, Vol. 24, p. 82, 1921), the stress in this portion of a tension bar is higher than elsewhere throughout the reduced section. When the load is reapplied after it has been released in order that the specimen may be removed from the machine for study and for photographing, the strain effect continues where it left off at the previous loading. This continues with each successive loading until the entire reduced section has yielded to the stress.

It is fascinating to watch a polished tension specimen while it is maintained under load just sufficient to cause the formation of strain markings at the moment of yielding. The pronounced localization of the yielding; the very definite boundaries which separate the permanently strained portions from the part of the specimen which, as yet, shows no evidence of having yielded; the slow, often intermittent, advance of this boundary as the condition of permanent strain advances into the "unstrained" metal, all serve to emphasize the progressive nature of the process of the yielding or permanent straining.

When magnified slightly, the surface strain markings are found to have a somewhat rippled appearance, as is shown in Fig. 5. A previously polished surface takes on a matt finish within the strain markings, on account of the rippled surface which forms as yielding occurs. It will be noted that the ripples are roughly parallel to one another and approximately at right angles to the direction in which the stress was applied. As the specimen yields more and more, the strain markings widen and form branches; new strain markings also appear, usually just ahead of the pre-existing ones (that is, in the direction in which the strain effect is advancing). The size of the ripples on the surface of the strained areas is very much larger than the grain size of the material. Each elevation or "ripple" apparently is made up of a large number of grains.

Etching Methods—An etching method for revealing strain effects in mild steel has been described by Adolf Fry ("Kraftwirkungsfiguren in Flusseisen dargestellt durch ein neues Ätzverfahren, *Kruppsche Monatshefte*, Vol. 2, p. 117, 1921; *Stahl und Eisen*, Vol. 41, p. 1093, 1921), and is usually referred to by his name. This etching reagent consists essentially of copper chloride (or copper ammonium chloride) dissolved in an aqueous solution of hydrochloric acid. Those portions of a mild steel which have been permanently strained are attacked more readily than those parts which have not yielded

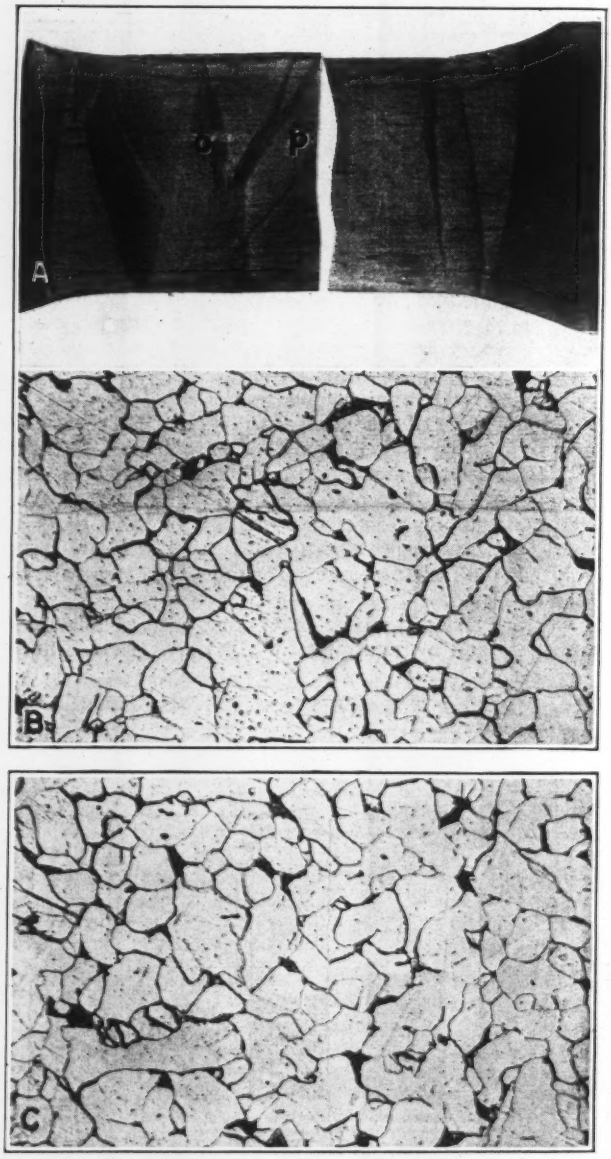


FIG. 7—MICROSTRUCTURE OF MILD STEEL STRESSED UNTIL YIELDING OCCURRED

a. Appearance of an 18-in. specimen with strain markings developed at the two ends; full size.

b. Structure corresponding to the point *o*—that is, where the metal "yielded"; magnification, 250.

c. Structure corresponding to "unstrained" metal, at the the point *p*. There is no noticeable difference between the two.

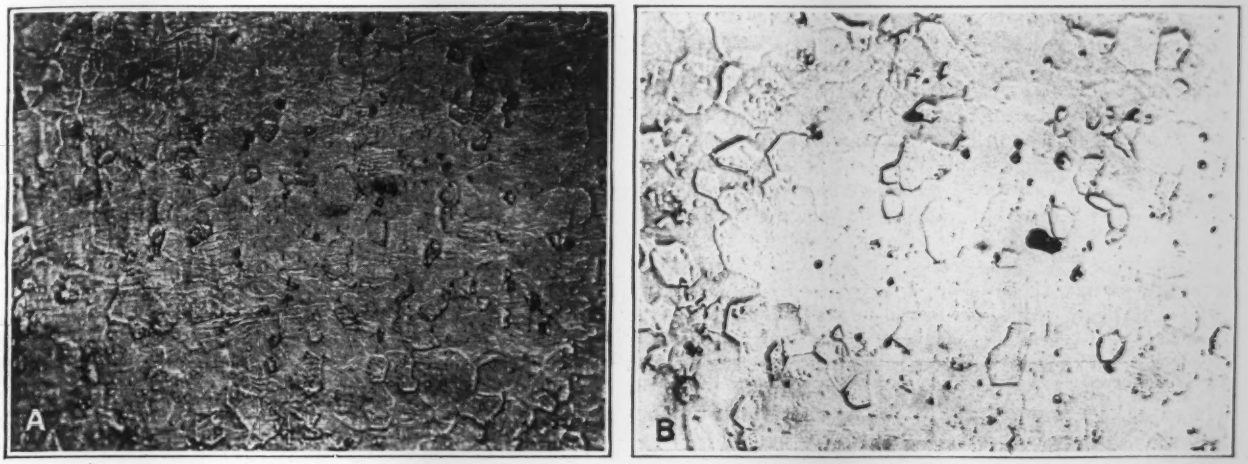


FIG. 8—EFFECT OF STRESSING MILD STEEL UNTIL "YIELDING" OCCURS
Structure as shown by the surface examination of a specimen polished and etched before straining; magnification, 250.
a. Structure within the strain markings. *b*. Structure of immediately adjacent metal which had not yielded under stress.

under stress. This is well shown by Fig. 6, which depicts some results obtained by J. D. Jevons ("Strain Detection in Mild Steel by Special Etching," *Jour. Iron & Steel Inst.*, Vol. 111, p. 191, 1925) with this reagent on a series of mild steel bars which had been permanently strained in tension by different amounts. These results, which were obtained by etching machined sections of the strained specimens and thus represent the condition of the interior of the specimens, are in very close agreement with the surface strain markings shown in Figs. 3 and 4. The gradual and progressive yielding of the metal as the strain effect, which begins at the ends of the reduced section close to the fillet, advances along the length of the reduced section is clearly shown. Not until relatively late in the test does the process of yielding extend into the shoulders of the test specimen. Fig. 6 also shows the strained condition near the ends of the specimens which resulted from the gripping of the specimen in the testing machine.

Microscopic Examination—It has frequently been reported that examination of the microstructure of mild steel which has been stressed just above the yield point shows nothing, as a rule, which can be considered as characteristic of material which has been strained in this manner. If the microscopic examination is made on sections cut from the strained bar, polished and etched in the ordinary manner, no significant difference will be seen in those portions corresponding to the strain markings as compared with the unstrained portions. (See Fig. 7.)

However, if the surface to be examined microscopically is prepared before the specimen is strained, the nature of the effect on the microstructure of the permanent straining can be shown, as is illustrated by Fig. 8. It will be seen from this illustration that many of the grains within the strain markings show distinct evidence of deformation by slipping, the slip bands (that is, the traces of the slip planes on the surface of the specimen) in one grain being approximately parallel to those in the other grains and at right angles to the direction of stress application. Not all of the grains show evidence of deformation by slipping; evidently this effect is confined to those grains which are favorably oriented crystallographically, with respect to the direction of the applied stress. Presumably slipping occurs first within those grains in which the stress acts along planes of easy slip.

It is evident, therefore, that the initial strain effect produced in mild steel by stressing it until yielding occurs is a case of deformation by crystal slip. Unlike the more pronounced plastic deformation which occurs as the material is stressed well above the yield point, the effect seems not to be general for all of the grains. Only part of the grains respond during the yielding of the metal, and in none of the grains is the effect pronounced enough so that the form of the grain is noticeably changed.

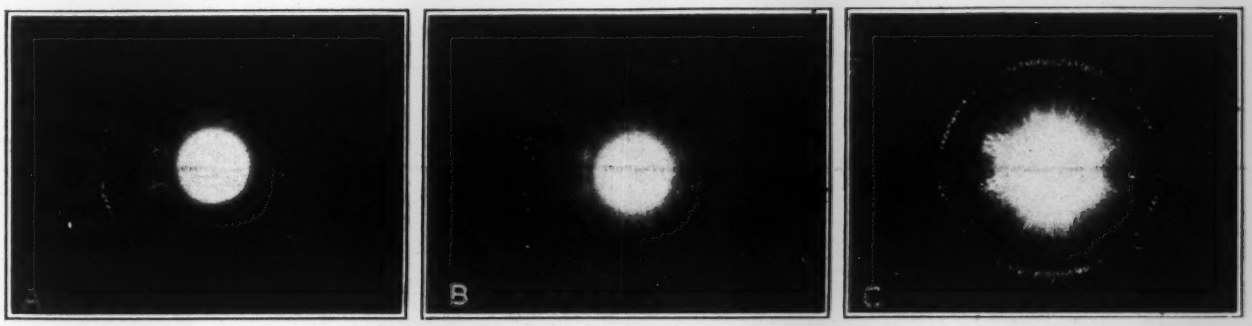


FIG. 9—X-RAY PATTERNS OF STRESSED STEEL
The X-ray beam was passed through (Laue method) a specimen of thin steel strip which had been stressed in tension.
a. X-ray pattern of unstrained steel immediately adjacent to the strain markings.
b. Similar pattern of steel which was permanently strained—that is, which "yielded" under the applied load.
c. Similar pattern of metal at the end of the specimen where it was gripped.
Note that *a* and *b* are essentially alike. The feature shown in *c* (asterism) is indicative of severe strain. If the specimen should be stressed considerably above the yield point, this feature of the X-ray pattern, probably intensified, would be obtained throughout the reduced section.

X-Ray Examination — The X-ray examination of strained metals has proved to be an exceedingly useful means for the study of strain in metals, especially for showing how this condition is related to the crystal structure—for example, which of the crystallographic planes are concerned mainly in the phenomenon of deformation by slipping and how the condition of "preferred orientation" in severely deformed metals is brought about. In the case of steel which had been stressed only sufficiently to produce the initial strain effects, however, an X-ray examination (Fig. 9), failed to give any clear indications as to the nature of the change which had been brought about. Evidently this method is not a suitable one for demonstrating whether or not a steel has been stressed to the yield point; a more severe strain effect, as is shown by the ends of the specimen where it was gripped for carrying out the tension test (Fig. 9*c*), is necessary in order that clear indications can be obtained by the X-ray method.

Strain Beyond the Yield Point; Cold Working—When mild steel is stressed beyond the yield point, the reduced section of the specimen becomes quite uniformly strained along its entire length, as is shown at *e* in Fig. 6. The pre-existing initial strain markings on the surface formed during the yielding of the metal (Figs. 3 and 4) are almost entirely obliterated by the relatively high flow of the metal which takes place under the higher stress. Etching the surface of such a severely strained steel with Fry's reagent serves mainly to show that such parts have been uniformly strained.

Microscopic examination of such metal shows a marked change in the form of the grain. As the deformation (in tension) is progressively increased, they become longer and, if the deformation is very severe, as in wire-drawing, the grains assume the form of fibers. This change in the grain form is illustrated in Fig. 10. X-ray examination of such severely strained metal, unlike that of the same metal stressed only to incipient yield, shows a marked change in the X-ray pattern. This method not only has proved very useful in clarifying our knowledge as to what happens during the very severe deformation of metals but has many more practical applications, such as in the detection of a condition of internal strain in metals resulting from manufacturing operations and the treatment necessary for their removal.

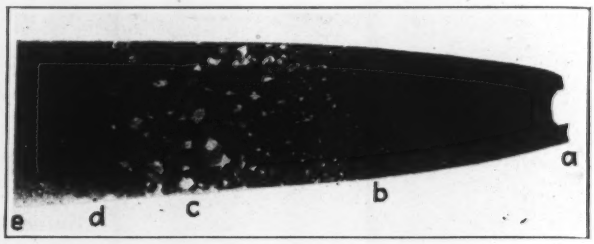


FIG. 11—EFFECT OF ANNEALING

Grain structure of a severely strained steel specimen in which the degree of strain varied along its length. A tapered bar which had been broken in tension was annealed six hours, 1,265 deg. F. (685 deg. C.) and then air cooled. Maximum stress on the bar at *a*, 49,300 lb./in.²; at *b*, 40,300 lb./in.²; at *c*, 35,700 lb./in.²; at *d*, 34,000 lb./in.²; at *e*, 32,500 lb./in.². Yield point of the steel as shown by strain markings, 26,800 lb./in.².

If severely strained steel is annealed, marked changes in the structure occur which, to the metallurgist, tell a good deal concerning the previous condition of the material. The changes are mainly those of recrystallization and grain growth, and the subject, which is quite involved, need be considered here only very briefly. All tests of this kind necessitate cutting specimens from the strained metal and subsequently annealing them. Steel which has been strained only sufficiently to produce yielding has, in tests carried out by the writer, shown no tendency toward recrystallization and grain growth upon annealing. On the other hand, steel which has been strained by stressing it considerably beyond the yield point shows an entire change in its microstructure after being annealed. The amount of the deformation or permanent strain produced, the annealing period and temperature, are all involved in the change produced in the microstructure. The method is particularly adaptable in those cases in which steel has been differentially strained. This is illustrated by Fig. 11, which shows the grain structure of a tapered specimen of mild steel which, after being permanently strained in tension by stressing it until fracture occurred, was annealed. The marked variation in the grain size according to the degree of strain produced is very evident, as the illustration shows.

Strain Lines Produced by Shock—A stress of the nature of impact or shock often produces a strain effect in iron and mild steel which is distinctly different from that

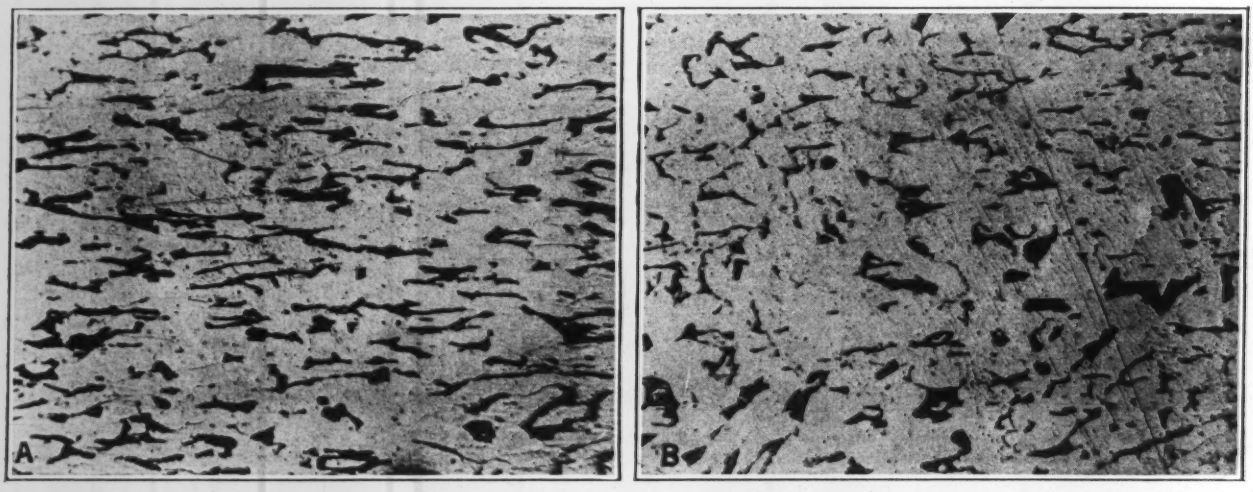


FIG. 10—EFFECT OF COLD WORKING ON GRAIN STRUCTURE

An 18-in. tension specimen similar to that of Fig 7 was stressed until fracture occurred. Magnification, 250. The micrographs show (*a*) the condition at the fracture and (*b*) about 2 in. from the fracture. Fig. 7 shows the original grain structure.

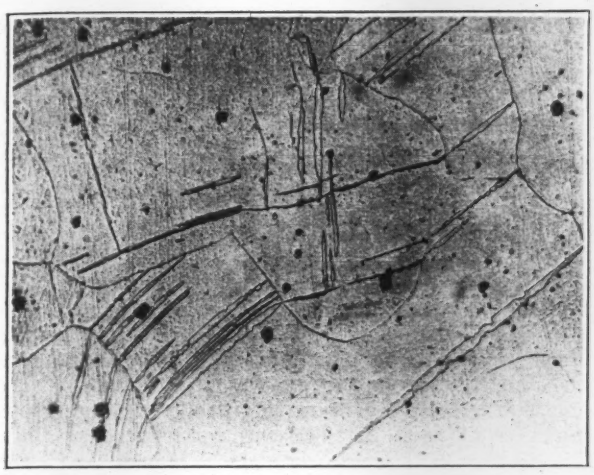


FIG. 12—STRAIN LINES DEVELOPED BY SHOCK
The micrograph, magnification 250, shows the structure near the fracture of a specimen of open-hearth iron broken by the single-blow notched-bar impact test. The narrow bands (Neumann lines) which extend across the grains are characteristic of the effect of very suddenly applied stress on iron and mild steel.

produced by static stress. This effect, which is shown in Fig. 12, is a microscopic feature and consists in the production of narrow bands extending across a grain. These bands, usually referred to as Neumann bands, are generally believed by metallurgists to partake of the nature of twinned crystals. The iron atoms within these bands are believed to have been changed sufficiently in their position by the shock so that, with respect to the unaltered portion of the grain, they bear the same relation that twin crystals do to each other. The sparkling crystalline fracture which steel broken by impact often exhibits undoubtedly is another manifestation of this behavior of iron under shock. The production of Neumann bands under impact seems to be peculiar to iron and mild steel—that is, steel containing a considerable amount of ferrite (iron).

Miscellaneous Strain Effects—It is well known that metals which have been permanently strained are harder than the same metal before straining. The increase in hardness produced depends upon the degree of deformation. The effect upon the hardness of mild steel produced by stressing it in tension until yielding began is shown in Fig. 13. The results summarized clearly show that localized hardening of the metal accompanies the yielding of the metal at the ends of the reduced section close to the fillets. Elsewhere the hardness has not been appreciably affected. If the load were maintained long enough so that the metal of the entire reduced section responded by yielding, it would be found that all of this portion of the specimen had been hardened to the same degree as is indicated by the two peaks in the hardness survey of the specimen, which was stressed until yielding had just started.

The hardening effect of stressing the same material until fracture almost occurred is also shown in Fig. 13. It will be seen that the hardening accompanying the yielding of the material is slight as compared with that produced by stretching the material nearly to the point of fracture; the maximum increase in hardness produced in the latter case was about ten times that in the former.

In general, the corrosion-resistance of strained metal is less than that of the unstrained metal. This is best shown if the strained metal is in metallic contact with the unstrained specimen; when wet with an electrolyte—for example, salt solution (sodium chloride)—the strained

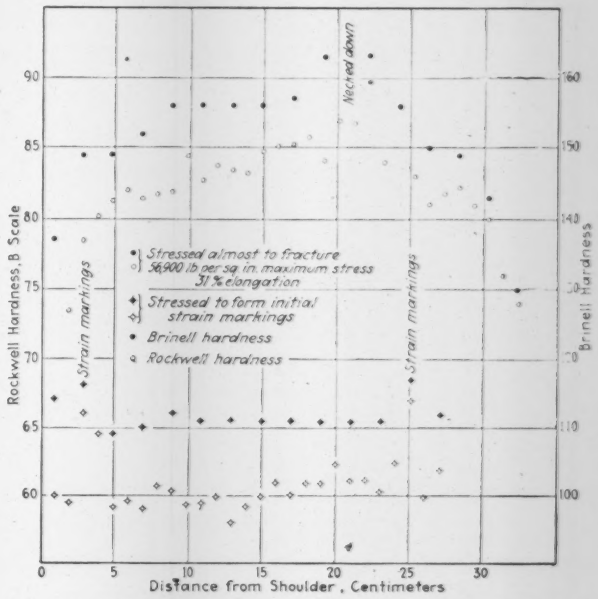


FIG. 13—HARDNESS SURVEY OF A STRESSED STEEL BAR
Lower points for tension bar stressed to incipient yield as shown by the formation of strain markings. Upper points for bar stressed until "necking down" occurred, just before fracture.

metal behaves as an anode with respect to the unstrained metal and therefore is corroded. The effect is still more striking and in actual service very much more serious in the outcome, if the same piece of metal has been treated so that it has been permanently strained locally—that is, the strain was confined to a limited portion of the specimen. Fig. 14 illustrates how the corrosion of a boiler pipe was localized in that part which had been deformed by hammering, the attack being so severe that perforation

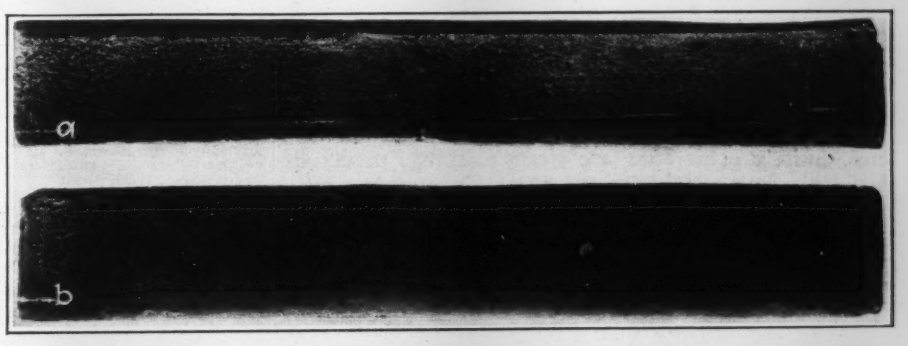


FIG. 14—EFFECT OF LOCALIZED STRAIN UPON THE CORRODIBILITY OF STEEL
a. Strip cut from the end of a boiler tube which was perforated by corrosion within a few months after installation.
b. Similar strip from the same end of the tube, machined flat and etched with Fry's reagent. Note the diagonal lines indicating strain. The anodic behavior of this strained portion with respect to the remainder will account for the severe localized corrosive attack.

FIG. 15—EFFECT OF STRAIN ON THE CORROSION OF STEEL

Note how most of the corrosion pits coincide with the strain lines which were set up by the cold shearing of the 1-in. plate. The greater part of the surface of the plate, away from the edges, showed only a general corrosive attack. The strain lines were revealed by etching with Fry's reagent.

of the wall of the tube resulted within a few months. In Fig. 15, the course of the corrosive attack of a steel plate by sea water will be seen to have been directed to a large extent by the strain lines produced during the shearing of the plate.

Summary

Certain conclusions as to the effect of strain upon mild steel may be drawn from the examples cited in the foregoing. The principal ones are:

1. The effects of strain upon metals, as recorded in the structure, have been considered for a mild steel. Similar effects are noticed, however, as a rule, in any steel containing a considerable amount of ferrite.

2. Elastic strain produces no change in the microstructure of a steel.

3. The changes corresponding to "yielding" under stress, which are of particular interest to engineers, are very evident and may be demonstrated (*a*) by the strain markings on polished surfaces or the flaking of oxide or other coatings, (*b*) by macroscopic etching with acidified copper solutions, (*c*) by microscopic examination of polished surfaces subsequently strained, and (*d*) by hardness surveys. X-ray examination is of very doubtful value for determining whether or not a steel has yielded under load. The strain effect of "yielding" is decidedly localized and progresses gradually throughout the reduced section as the load is maintained.

4. Stress beyond the yield point produces a progressively greater change in the appearance and the structure of steel. The surface, which becomes completely freed from any scale initially present, assumes a matt appearance, entirely obliterating the strain markings produced during the first yielding of the metal. The grain structure is greatly changed and a fiber-like structure is approached with high degrees of straining.

5. The effects of impact and shock stress on steel are recorded in the microstructure in characteristic and definite manner.

6. The corrodibility may be greatly increased as a result of permanent strain. This effect is likely to be most serious, from a practical standpoint, when the piece has been only locally strained, as in the case of the boiler tubes given herein.

Boyds Corners Dam—Why It Was Declared Unsafe

Pressure Line Outside of Middle Third, Even Without Uplift—Masonry Facing Probably Not Effective Section

TO SUPPLEMENT the facts reported in *Engineering News-Record*, Aug. 2, p. 176, on the Boyds Corners dam of the Croton water-supply system of New York City, which was recently declared unsafe by W. W. Brush, chief engineer of the New York Department of Water Supply, certain additional facts are now given. They include a complete cross-section drawing of the dam with calculated pressure lines, and two photographs taken a week ago. The drawing was prepared for Mr. Brush by A. S. Burgess, assistant engineer; the photographs were taken by a staff photographer of *Engineering News-Record* on Aug. 7.

Two pressure lines are drawn in the section, the inner one being for horizontal water pressure alone, with water at top of masonry or 3 ft. above spillway crest; the outer one for water pressure plus pressure from the upstream earthfill, this latter item of pressure being taken as equivalent to that of a 92-lb. liquid. In neither case is uplift taken into account; with uplift varying from half hydrostatic at the upstream face to zero at the downstream face, the inner line would be moved nearer the downstream face, while the outer line would pass quite outside the section at the critical plane.

Mr. Burgess has also calculated that with maximum water level held to 17 ft. below present top of masonry, the pressure line would be held within the middle third even for combined water and earth pressure and uplift, provided the earthfill were taken down to water level.

In these analyses the masonry is counted as weighing 148 lb. per cu.ft., a figure which Mr. Burgess believes

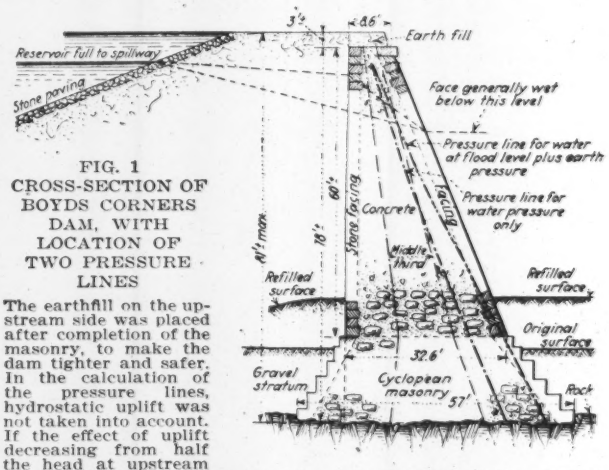
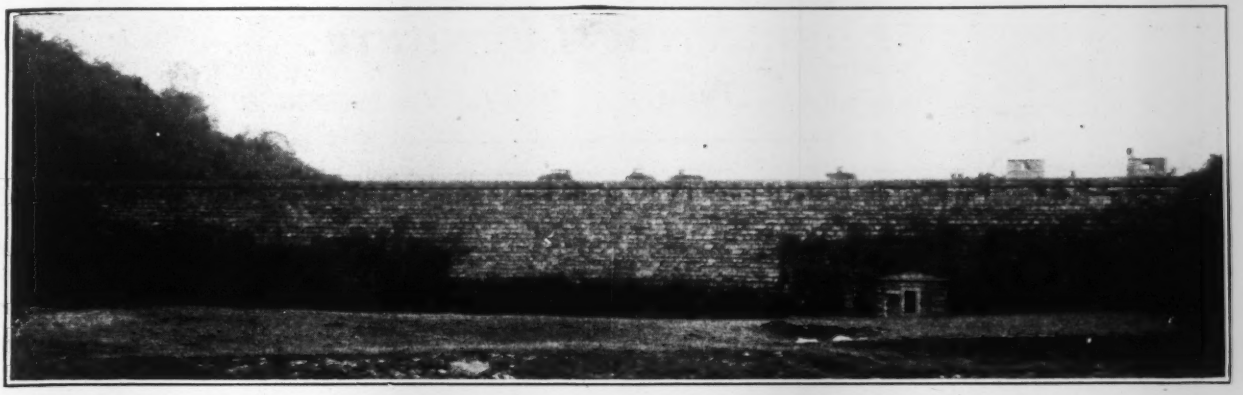
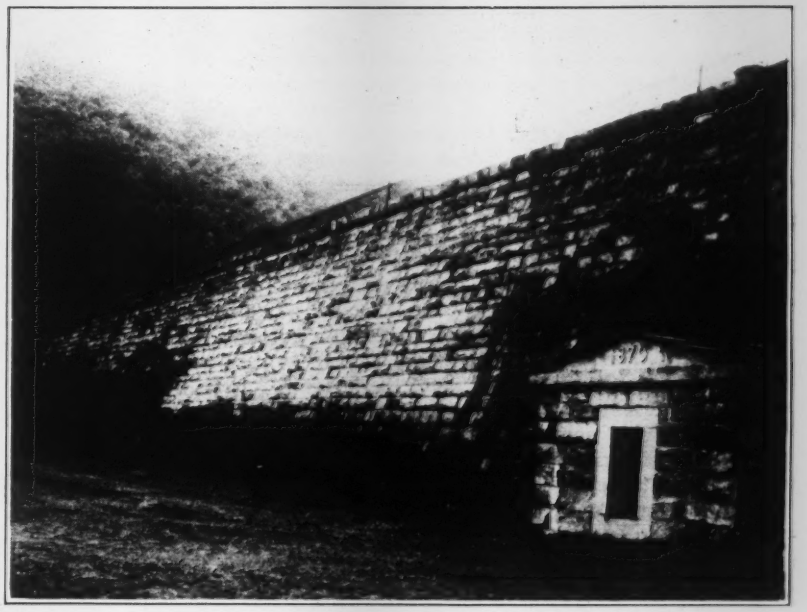


FIG. 1 CROSS-SECTION OF BOYDS CORNERS DAM, WITH LOCATION OF TWO PRESSURE LINES

The earthfill on the upstream side was placed after completion of the masonry, to make the dam tighter and safer. In the calculation of the pressure lines, hydrostatic uplift was not taken into account. If the effect of uplift decreasing from half the head at upstream face to zero at downstream face be included, both pressure lines will be shifted downstream and the outer one of the two will pass beyond the face.

appropriate in view of the large proportion of stone in the cyclopean concrete interior. The full section, that is concrete core plus stone facing, is assumed to be active in resisting. On this latter point, however, it is reported that the stonework on a large area in the central part of the downstream face—that which has the greatest height of dry or light-colored surface, Fig. 3—is bulged or





FIGS. 2 (ABOVE) AND 3 (BELOW)—TWO RECENT VIEWS OF BOYDS CORNERS DAM

Taken Aug. 7 by *Engineering News-Record* staff photographer. The lower dark part of the face owes its color to being wet; there is much vegetation on this part of the face, and frequent reddish streakings of clay appear. The nearly horizontal upper boundary of the dark area is interpreted as the foot of the saturation slope in the earthfill and the masonry. Where the light area extends below this line, in the middle part of the length, the facing is believed to be bulged away from the concrete core. A decided jet of water flowed out of the stonework at the point where a sloping stick may be seen in Fig. 3, just in front of the man's figure.

sprung away from the concrete and on this account is unlikely to be an effective part of the resisting section. Further the masonry in the dark-colored or wet parts of the face has many open joints, which will take one's whole hand, and this part of the face may also be largely ineffective.

Where the photographs show the face dark colored the masonry is continually wet with a film of water, in places quite evidently flowing; there are many orange or reddish clay streakings, and extensive vegetation growth. At one point near the base (where a slanting stick may be seen in Fig. 3), a stream of water was spouting out several feet at the time the photograph was taken; it is also reported that such flows are not constant, but appear variously at different points.

The Boyds Corners dam was one of the earliest of the Croton headwater reservoir structures to be built. Twenty years later, when the Carmel or West Branch reservoir was built, just below it, Alphonse Fteley, chief engineer of the Croton Aqueduct Commission, planned it with a spillway of unusual width and depth, because, as he stated to some of his engineers, the Boyds Corners dam was weak and he desired to provide extra discharge capacity at the lower dam for use in case of failure of the upper one. No studies appear to have been made of the effect which sudden release of the Boyds Corners storage would produce in the reservoir below, but it is known that the direct path of discharge would be toward an earth dike section of the Carmel reservoir.

Since work started on cutting down the spillway and its rough rock-cut approach and discharge channels a strong protest against the proposed lowering of the water level has been made by residents along the reservoir. The pool has for nearly 60 years formed a valued landscape feature, which would be destroyed if the water were permanently lowered, it is asserted. Due to the steeply sloping banks of the reservoir, however, the water department holds that lowering the water level does not materially change the scenic effect of the reservoir lake. Vegetation is expected to cover the exposed slope before the end of the season.

Geodetic Survey to Co-operate With Canada

Work planned by the U. S. Coast and Geodetic Survey for the coming fiscal year includes co-operation with the Geodetic Survey of Canada in a study of the level nets of the two countries with a view of joining them into a single system. In the adjustment it will be necessary to consider the slope of the mean sea level to the northward along both the Atlantic and Pacific coasts, and also the difference in the mean sea levels of the Atlantic and Pacific oceans. An investigation of these differences was made by the U. S. Coast and Geodetic Survey about a year ago. No definite explanation for them has been determined, as the phenomena may be due to a number of causes such as differences in atmospheric pressure, differences in prevailing winds and varying densities of the sea water. The general level of the Pacific Ocean is about 1½ ft. higher than that of the Atlantic.

Engineering Literature

A Monthly Review of Books and a Listing of New Publications

Valuation of Income

REVIEWED BY E. P. GOODRICH
Consulting Engineer, New York City

PRINCIPLES OF VALUATION—By John Alden Grimes and William Horace Craigue. New York: Prentice-Hall, Inc. Cloth; 6x9 in.; pp. 274. $10.

More than ten years ago in the *New York Times Analyist* the reviewer propounded the thesis that as to any public utility a "simple or composite" interest rate could be fixed depending upon the character, age and history of the enterprise, whereupon a valuation could be computed based on a given investment. This book demonstrates the soundness of the thesis and one may surmise that the methods outlined in it are actually employed in the offices of the Treasury Department in connection with the valuation of properties for income tax purposes. As a matter of fact the title of the book might be slightly amplified with propriety to read "Principles of Valuation of Income."

All engineers are acquainted with compound interest and sinking fund formulas of the simpler types, and many engineers have developed formulas for use in connection with their engineering practice in valuations covering the more complicated fields of deferred returns beyond the development period, valuations involving depletion of capital such as occur in mining work or in connection with heavy deferred maintenance charges. In spite of the interest of the profession in this field few books and papers have been published covering it. The authors include in their consideration the work of Fisher, Hoskold, King, Morkill and others.

Statistical data of great value with reference to interest rates are found in seventeen appendices, many of the data being presented in graphical form. An interesting chapter on the causes of variation in interest rates is enlightening. Two important chapters discuss the Valuation of Income Subject to an Income Tax and The Discount for Hazard Method of Valuation.

What the authors consider the most important contribution made by them is the development of a compound interest sinking fund annuity formula involving speculative, semi-speculative and safe interest rates on different portions of an investment. Two chapters are given to the development of a general formula, the formulation of six mathematical premises of valuation, the modification of the formula required to cover each premise and an arithmetical illustration under each. The time distribution of income may be terminable, perpetual, regular or irregular, and modifications are indicated so that the formula will meet the usual commercial cases and methods. The algebraic relations stated by the authors are shown by them to be the basis of the entire structure for the valuation of income by mathematical premises. They also point out wherein various algebraic sinking fund valuation formulas have failed to stand the test of arithmetical application. In general it may be stated that their formulas are in reality algebraic series built up by mathematical induction. While the formulas are primarily applicable to sinking fund operations, the authors show how they may easily be adapted to non-sinking fund conditions by substituting zero in place of certain of the algebraic quantities.

All engineers engaged in valuation work and in income estimating will find in the book much of interest and value. This is exemplified in Chapter III wherein six common types of income are discussed.

The six mathematical premises of valuation presented by the authors are: (1) Compound interest deferment method of valuation. (2) Compound interest actuarial method of valuation. (3) Compound interest sinking fund method of valuation. (4) Sinking fund valuation method with two rates of interest of the Hoskold type. (5) Sinking fund valuation method with two rates of interest of the Morkill type. (6) Sinking fund valuation method with three rates of interest, the type developed by the authors.

The appendices include, in addition to the items already noted, 26 tables, including not alone the usual computations of the amount and the present worth of money at the various rates of income, but also the same factors for various other sinking fund formulas and of the factor of safety at speculative rates of interest based upon a large number of safe rates.

Docks, Wharves and Piers

THE DESIGN, CONSTRUCTION AND MAINTENANCE OF DOCKS, WHARVES AND PIERS—By F. M. Du-Plat-Taylor, M. Inst. C.E., M.I.Mech.E., M.I.Struct.F., M.Cons.E., M.Soc.I.E. (France), Consulting Engineer, formerly of the Engineering Staff of the Jersey Docks and Harbour Board of the London & India Docks Company and the Port of London Authority. With an Introduction by Sir John Broodbank. London: Ernest Benn, Ltd., Cloth; 7x10 in.; pp. 495; 455 illustrations. 70s. net.

Thirty years of experience as a dock and harbor engineer provide the background for this comprehensive work on the design, construction and maintenance of docks, wharves and piers. Observations are confined mainly to practical considerations in order that the book may be useful to both engineers and managers of port facilities, yet at the same time enough of the theoretical considerations are included to make the book of value to students. The author's observations are based upon his experience in dock and harbor work in England and most of his illustrations of typical structures are drawn from either British or Continental European practice. Such practice is not so unlike American practice as to invalidate it, at least as a basis for similar work here in America.

A wide variety of structures is discussed, and the illustrations are so numerous and well chosen as to make the book a remarkably complete record of Continental practice in the construction of port facilities. A résumé of the chapter headings gives the best running picture of the contents. They cover the following subjects: Harbors of the ancients; organization and management of docks and harbors; form of accommodation, tidal or impounded; calculations for dock walls; dock and wharf walls; jetties and landing stages; drydocks and floating docks; lock entrances, lock gates and gate machinery; caissons and sluices; dock and wharf buildings and machinery; conveying and elevating machinery; dredging; construction materials and organization of work; dams, temporary works and plant; and maintenance.

Considerable space is devoted to the consideration of tidal accommodations for the larger types of vessels due to the present tendency toward the use of such ships.

The Subway System of Paris

LES CHEMINS DE FER URBAINS PARISIENS: Historique—Modalités de la concession Construction de l'infrastructure—By Louis Biette, Inspecteur Général des Ponts et Chaussés Inspecteur Général des Travaux de Paris. Préface by F. Bienvenüe, Inspecteur Général des Ponts et Chaussées, Inspecteur Général des Services Techniques du Métropolitain et du Port du Aris Avec le patronage de la Société des Ingénieurs Civils de France. [Encyclopedie du Génie Civil et des Travaux Publics.] Paris: J.-B. Baillière et Fils. Paper; 6x9 in.; pp. 520; 248 line cuts.

A complete history of the rapid transit system of the city of Paris, France, is given in this book by Louis Biette. Beginning back in 1855, when the idea of a transit system for Paris was first proposed, he carries his narrative through the period in which such a system was definitely laid out and construction of the first line was begun, up to the present day, outlining what has been built, what work is now under construction and what future extensions are proposed. Details of the concessions granted to the operating companies and of the methods of financing them are given.

The present system is owned and operated chiefly by two companies, the Métropolitaines and the Nord-Sud. As far as the public is concerned, however, numerous transfer points make the two systems practically one.

The greater part of each system is in subway, generally close to the street surface, but at several points, notably close to the subaqueous river crossings, the lines are at a considerable depth and escalators are provided at the stations. The subways are built in the alluvial ground and soft sedimentary rock underlying Paris. Except at isolated points, the underground lines are laid in subways of arched masonry construction, built either in open cut or by tunneling. Shield tunneling, similar to that used for the river crossings of New York, was used in driving some of the tunnels under the River Seine. The methods of construction are given in great detail. For those interested in subway or tunnel construction who read French, this book will be found to be an excellent record of the way such work is carried on in Paris, but even for those who do not read French, the portion of the book which deals with methods of construction is not without interest, because it is freely illustrated with excellent drawings showing all the various types of construction.

The book is one of a series on engineering subjects, published under the patronage of the Société des la Ingénieurs Civils de France and the Société d'Encouragement pour l'Industrie Nationale.

Management of Motor Traffic

MOTOR TRAFFIC MANAGEMENT—By G. Lloyd Wilson, Ph.D., Assistant Professor of Commerce and Transportation, Wharton School of Finance and Commerce, University of Pennsylvania, formerly traffic manager of the Chester Ship Building Company, Ltd., and the Merchant Shipbuilding Corporation; author of "Traffic Management," etc. New York and London: D. Appleton & Co. Cloth; 6x9 in.; pp. 251; 56 line cuts. $3.

Little has been published in book form on the rapidly growing problem of managing motor traffic. In this book, G. Lloyd Wilson, the author of an earlier work on traffic management, attempts to analyze the problem of motor freight and passenger carriers, in obtaining and handling their traffic. Using his experience in railway and steamship freight traffic problems, the author has outlined the similar problems which must be met in obtaining freight and passengers for motor transport. Such problems as the proper classification of package freight for motor transport, motor freight rates and tariffs, factors which affect both passenger and freight tariffs, and the insurance of motor vehicles are dealt with. Also, the author outlines what municipal, state and federal regulations must be met in the operation of both motor trucks and buses as common carriers.

For Younger Constructors

CONSTRUCTION JOB MANAGEMENT—By Charles F. Dingman, M.Am.Soc.C.E., M.Am.Soc.M.E. New York and London: McGraw-Hill Book Co., Inc. Cloth; 4x7 in.; pp. 220; 26 line cuts. $2.50.

Building construction largely has been considered by the author in developing this book of advice and directions for construction superintendents. Essentially the book is designed for younger constructors and has been kept as elementary as practicable in thought and language. It is written particularly for men without technical education. The successive chapters deal with preparing to start the job; equipping the job; getting the work done; organizing the job; handling masonry and concrete operations; handling fireproofing construction; handling plaster and stucco work; handling carpenter work, and relations with subcontractors.

The New Safety Movement

SAFETY AND PRODUCTION: An Engineering and Statistical Study of the Relationship Between Industrial Safety and Production—A Report by the American Engineering Council. New York and London: Harper & Brothers. Cloth; 6x9 in.; pp. 414; line cuts. $5.

From about 1912, when the safety idea first impressed itself on the public consciousness, to 1921, results in bettering conditions were unusually satisfactory and not difficult of accomplishment. Since about 1921, however, accidents have increased both in number and severity. Belief that this latter condition was not a sign of the falling down of the safety movement itself, but rather a failure to adapt accident prevention to changing conditions, led the American Engineering Council to undertake the investigation of safety in industry which resulted in this report. The investigation was directed to a study of the truth or falsity of the thesis that "the safe factory in general is the efficient factory, and the efficient factory in turn is the safe factory." The thesis was born of the belief that although periods of rising accident rates correspond to periods of heightened industrial activity the unusually successful results obtained by some organizations during this period could be duplicated generally.

Experience records of a large number of industrial plants and establishments from which both accident and production rates could be determined were gathered. The book is largely made up of charts based on these data but contains more than 80 pages devoted to a general discussion of the problem, the findings of the committee and its recommendations. Some of the industries studied were cement, chemical, coal mining, coke, light and power, electric railway, gas, iron and steel, building and metal working, mineral mines, paper and pulp and paper products, quarries, railways, telephone and telegraph, textile and woodwork.

The conclusion of the committee is that a new safety movement, very different from the old one, must be inaugurated. It must meet, not the conditions of ten years ago, but the increasingly difficult conditions of an industry continuously growing more intense. To accom-

plish this it is declared imperative that the safety movement be placed under executive guidance; it must be considered in the same class with other executive interests. A new safety machine with executive control and maintenance is envisioned in this book of statistical studies.

British Municipal Government and Activities

THE MUNICIPAL YEAR BOOK FOR 1928—Founder and Director, Sir Robert Donald. Edited by Major Arthur Skey, with an introduction by Neville Chamberlin, Md., Minister of Health. London: The Municipal Journal. Half leather; 6x9 in.; pp. 910 + LXXXI advertising pages. 15s.

Year by year since its first publication in 1897, this combination of a very complete directory or listing of municipal officials, a description of the municipal enterprises in each city, town, urban and rural district, with general reviews of such of the major fields as water supply, lighting and with also a considerable amount of statistical matter, has become more inclusive and valuable. The extensions, however, relating to other than the directory features have always been complete. New topics covered in the present volume are road costs and income, refuse collection and disposal cost and street cleansing costs.

Highway Curves

WIDENING AND SUPERELEVATING OF ROADWAY CURVES: A Field Book for Highway Engineers—By John H. Fletcher, C. E. Topeka, Kan.: John H. Fletcher, P. O. Box 231. Cloth; 3x4¼ in.; pp. 63; 8 line cuts; 24 tables. $2.50.

Highway engineers who desire to undertake superelevation and widening of highway curves on the exact basis of the transition curve and the spiral will find this little book a useful presentation of the formulas and tables required. Briefly, the purpose of the book is to develop formulas for determining outside as well as inside curve widening; to determine superelevation by the application of the factors to the widening offsets, and to construct tables giving the functions of roadway widening for a set of standard curves for 16- to 24-ft. roadways. Inside widening is given 266 pages and outside widening 6 pages, and there are 15 spiral tables.

Water as an Aid to French Agriculture

HYDRAULIQUE AGRICOLE—By Paul Lévy-Salvador, Ingénieur des Constructions Civiles, Chevalier de la Légion d'Honneur. Vol. I. Considerations générales sur les Sources et les Cours d'Eau. Réglementation des Barrages et Prises d'Eau sur Cours d'Eau Non Navigables Ni Flottables. Maintien du Libre Écoulement des Eaux. 3e. Edition [Bibliothèque de l'Ingénieur de Travaux Publics]. Paris: Dunod. Paper; 5x7 in.; pp. 655; 292 line cuts. 68 fr.

Within the limits to which it is confined, this book presents an elaborate and meticulous review of French practice in the use of water as an aid to agriculture. It is the first of a series of three volumes, and confines itself to consideration of collection works and river hydrology.

Beginning with first principles, the author deals progressively with intake structures, dams and spillways, revetments and other structures of like nature. Design is touched upon lightly; the principal emphasis is placed upon preliminary planning and the legal aspects of the use of water. Consideration of maintenance is limited to chapters describing present methods of cleaning and flushing reservoirs and channels. Much space is devoted to reproductions of the many documents required by French law of persons proposing the construction of hydraulic structures; in fact, the book is a complete manual of bureaucratic procedure. An appendix gives valuable statistics on the rivers and watercourses of France.

No attempt is made to go outside of France or French practice, as the book is essentially national in character and treatment. It succeeds in its purpose of giving a clear and accurate study of agricultural hydraulics in its larger aspect, as concerns French practice.

Niagara Falls

THE FALLS OF NIAGARA—By Glenn C. Forrester. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. 155; halftones and line cuts. $2.50.

Few subjects for speculation are more fascinating than the course of past events from the evidence of the happening which still exists, be it a few marks left on rails and ties by a recent railroad derailment or the marks left on hard rocks by the passage of prehistoric glaciers. The mute evidence of past events written upon the rocks along the Niagara River gorge is a fruitful source of such speculation. But to read it aright, one must go far afield for additional data. This Mr. Forrester has done in his book. His conclusion as to the events which led up to the formation of the present falls of Niagara are based upon a thorough study of the geologic history of the whole northeastern part of the American continent.

Going back through the centuries to the time when the sedimentary rocks which now form the sides of the Niagara gorge were laid down in the sea, Mr. Forrester has assembled from the observations and deductions of geologists a connected history of the region. The origin of the prehistoric rivers which cut north and south across the northern part of the continent, the turning up of the great ridges east and west across that part of the country, one of which forms the present Niagara escarpment, the formation of the first Great Lakes—the predecessors of the present ones—the reasons why these lakes first drained southward and then eastward, finally forming the present Niagara River, all these developments as they are believed by geologists to have come about are described in considerable detail.

Mr. Forrester has written for popular consumption, but in so doing he has found it possible to include enough scientific data to make the book of value to those who are looking for something more than a popular story of how Niagara Falls came into being.

American Economic History

INTRODUCTION TO AMERICAN ECONOMIC HISTORY—By Walter W. Jennings, Ph.D., Professor of Economics in the University of Kentucky. New York: Thomas Y. Crowell Co. Cloth; 6x9 in.; pp. 546; 100 charts. $3.

Here is a reasonably successful effort to present in concise and usable form the essential facts of our economic history as a nation. By organizing his chapters each around some topic—as Labor, Mining, Tariff Policy, Money and Banking—the author has added much to the convenience of the reader who wishes to review briefly the development of any one or more of those topics. This arrangement, however, does not make for easy reading of the book as a whole, neither does it present a vivid and illuminating picture of the interplay of all the forces that have molded the economic life of the American people.

Publications Received

THE BIOGRAPHY OF HOOVER noticed in our issue of June 21, p. 979, is published by the Century Company, New York City, a fact unfortunately omitted from the heading of the review.

STATE HIGHWAY TRANSPORTATION SURVEYS, begun a few years ago by the U. S. Bureau of Public Roads in conjunction with the state highway departments, have been increased by surveys in Ohio, Vermont and New Hampshire, the reports of which have recently been published. As did previous reports, these just issued consist of three sections: (1) A summary of the principal conclusions, (2) the detailed data of the survey and (3) the proposed plan of highway improvement indorsed by the federal bureau and the road department of the state. These recent volumes show clearly the improvement in contents and presentation which has come as the federal engineers have become more sure of themselves. There occurs to one very few questions of significance to which these latest reports do not give an answer. The reports can be secured from the Bureau of Public Roads or from the highway department of the state for which the survey was made.

BUILDING SCIENCE ABSTRACTS, a monthly periodical, which for June extends to 48 pp., is a continuation of privately circulated neostyled sheets. Since January, 1928, "1,160 abstracts and references" have been drawn from 123 journals not confined to Great Britain. The June issue extends to 48 pp. of material, grouped under ten main heads, of which six relate to specific materials and groups of materials, one to materials in general and tests, one to elements of structures, one to housing and domestic engineering and the last to specialized construction. The work is sponsored by the Department of Scientific and Industrial Research, Westminster. Publication is made possible by the generous support of the Institute of Builders. Apparently the periodicals utilized are housed and the abstracts prepared at the Building Research Station, Watford, England, in charge of R. E. Stradling, director of building research. Obtainable for 10s. per year or 9d. per single number, from H. M. Stationery Office, London, England, and various agencies throughout the world, including the British Library of Information, 44 Whitehall St., New York City.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

CLIMATALOGICAL DATA for Northern and Western Tropical America—By W. W. Reed. Sup. 31, Monthly Weather Review. Paper; 10x12 in.; pp. 21; illustrated. 10c. from Superintendent of Documents, Washington, D. C.

COMMERCE YEARBOOK, 1928: Vol. 1, 1928.—Compiled by Bureau of Foreign and Domestic Commerce, Julius Klein, Director. Linen; 6x9 in.; pp. 708; a few line cuts and many tables. $1.25 from Superintendent of Documents, Washington, D. C.

DETERIORATION OF STRUCTURES IN SEA-WATER: Eighth (Interim) Report of the Committee of the Institution of Civil Engineers. London: H. M. Stationery Office. New York: British Library of Information, 44 Whitehall St. Paper; 6x9 in.; pp. 75; illustrated. 3s.

EFFLORESCENCE ON FACE-BRICK WALLS, Cause and Prevention of, and of Kiln and Dry-House Scum. By L. A. Palmer, Research Associate, Bureau of Standards. Paper; 7x10 in.; pp. 51. 21c. from Superintendent of Documents, Washington, D. C.

ELEMENTS OF HYDROLOGY—By Adolph F. Meyer, C.E., M.Am.Soc.C.E., M.Am.Soc.M.E., Consulting Hydraulic Engineer; formerly Associate Professor of Hydraulic Engineering, University of of Minnesota. Second Edition Revised. Cloth; 6x9 in.; pp. 522; 287 illustrations, mostly line cuts, including folding plates; also folding maps in colors. $5.

FLOOD CONTROL—Compiled by Lemar T. Beman, A.M., LL.B., Attorney at Law, Cleveland, Ohio. [The Reference Shelf, Vol. V., No. 7.] New York: The H. W. Wilson Co. Cloth; 5x8 in.; pp. 162. 90c.

A brief summary of arguments for and against the federal government assuming entire responsibility for flood control in the lower Mississippi Valley and for the payment of the entire cost of flood-control work. Abstracts from articles and published statements favoring both sides of the case are given, together with a fairly complete bibliography of material on the Mississippi flood situation published during the last few years.

GROUND-WATER RESOURCES OF MISSISSIPPI—By Lloyd W. Stephenson (and others). With Discussions of the Chemical Character of the Waters by C. S. Howard. Prepared in Cooperation with the Mississippi Geological Survey. Paper; 6x9 in.; pp. 515; illustrated. 90c. from Superintendent of Documents, Washington, D. C.

HANDBUCH DER HOLZKONSERVIERUNG—Unter Mitwirkung K. Bräuning (and 11 others) herausgegeben von Freidrich Mahlke. Second Edition. Berlin: Julius Springer. Cloth; 6x9 in.; pp. 434; 191 line cuts and halftones. 29 marks.

HIGHWAY ENGINEERING, Fourth Short Course, Texas, 1928—Edited by J. T. L. McNew, Professor of Highway Engineering; College Station, Texas: Agricultural and Mechanical College of Texas. Paper; 6x9 in.; pp. 188. 50c.

HIGHWAY TRANSPORT, First Annual Conference on, and Sixth Meeting, Michigan Motor Bus Association, 1927. Ann Arbor: University of Michigan. Paper; 6x9 in.; pp. 80.

ICE ENGINEERING—By Howard T. Barnes, F.R.S., Professor and Former Director of Physics, McGill University, Montreal, Canada. Montreal: Renouf Publishing Co. Cloth; 6x9 in.; pp. 364; halftones and line cuts. $5.

IRRIGATION REQUIREMENTS of the Arid and Semi-Arid Lands of the Missouri and Arkansas River Basins—By Samuel Fortier, Senior Irrigation Engineer, Division of Agricultural Engineering, Bureau of Public Roads. Paper; 6x9 in.; pp. 112; line cuts and tables. 20c. from Superintendent of Documents, Washington, D. C.

JAHRBUCH DU ELEKTROTECHNIK, 1926—Edited by Dr. Karl Strecker. Munich and Berlin: R. Oldenbourg. Cloth; 7x10 in.; pp. 268. 16 marks.

MOTOR VEHICLE ACCIDENTS IN CONNECTICUT, Fourth Study, 1927—By Rinehard Shelton Kirby, Department of Civil Engineering, Yale University, with an Introduction by Robbins B. Stoeckel, Commissioner of Motor Vehicles, State of Connecticut. New Haven: For the Hartley Corporation by the Yale University Press. Paper; 6x9 in.; pp. 48; tables and line cuts.

NEW JERSEY SEWAGE WORKS ASSOCIATION, Proceedings, 1928. Bound Brook, N. J.: John R. Downes, Secretary. Paper; 8x11 in.; illustrated.

NITROGLYCERINE AND NITROGLYCERINE EXPLOSIVES—By Phokion Naoúm, Ph.D., Director of Scientific Laboratories, Alfred Nobel Dynamite Company, Hamburg, Germany. Authorized English Translation with Notes and Additions by E. M. Symmes, Hercules Powder Co., Wilmington, Delaware. [Vol. I of World Wide Chemical Series.] Baltimore: Williams & Wilkins Co. Cloth; 7x10 in.; pp. 469; illustrated, chiefly by line cuts. $7.

THE SALES ENGINEER: Some Commercial Aspects of Metallurgical and Chemical Engineering—By Gilbert Rigg. London: Mining Publications, Ltd. Cloth; 5x7 in.; pp. 112. 10s.

TESTING OF MOTOR VEHICLE HEADLIGHTING DEVICES and Investigation of Certain Phases of the Headlight Glare Problem—By C. R. Granberry [Headlight Engineer]. Austin: The University of Texas. Paper; 6x9 in.; pp. 35; illustrated.

Describes tests made at the University of Texas to determine the characteristics of various commercial headlight lenses and reflectors, and the effect of strong light upon the abilities of observers to distinguish objects under conditions simulating night automobile driving. Lists devices which passed the tests successfully and are now approved for use in Texas.

A TREATISE ON CHEMICAL ENGINEERING Applied to the Flow of Industrial Gases, Steam, Water and Liquid Chemicals, Including the Pneumatic Transport of Powders and Granulated Materials. With Details for Calculating Fan Power, Pumping Power, Friction Losses in Pipes and the Like, Together with Full Practical Details of Measuring Flow and Viscosity of Gases and Liquids. A Practical Treatise for Engineers, Works Chemists, Chemical Engineers, Furnace Operators, Plant Designers, Works Contractors and Others—By Geoffrey Martin, D.Sc. (London and Bristol), Ph.D., F.I.C., F.C.S.; M.I.Chem.Eng., M.I.Struct.Eng. London: Crosby Lockwood and Son. Cloth; 7x10 in.; pp. given by chapters only; 188 illustrations, mostly line cuts. 63s.

SCIENTIFIC PURCHASING—By Edward T. Gushee, Purchasing Agent, The Detroit Edison Co., and L. F. Boffey, Editor, *The Purchasing Agent*, with a Foreword by Alex Dow, President, The Detroit Edison Co., President, Am.Soc.M.E. New York and London: McGraw-Hill Book Co., Inc. Cloth; 8x9 in.; pp. 196; 25 line cuts. $3.

Contending that the purchasing department of a firm should be organized in a manner comparable with the sales department, the authors have presented a guide to the efficient organization of such a purchasing department and an outline of its varied functions. The need of scientific purchasing is brought out in the first chapter in a convincing manner. The remainder of the book is devoted to showing how a scientific purchasing organization should be developed.

WATER PURIFICATION, Selected Papers from 1927 Annual Conference (W. Va.). Edited by E. S. Tisdale, Director of Conference and Director Division of Sanitary Engineering, West Virginia Department of Health, and L. V. Carpenter, Assistant Professor of Municipal and Sanitary Engineering. Morgantown, W. Va.: West Virginia University. Paper; 6x9 in.; pp. 99; illustrated.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Effect of Distance on Operating Costs

Sir—I have read with interest the article by N. D. Douglas in your issue of Aug. 2, p. 168. The figures arrived at therein may be applicable to roads in California, but in my opinion they are altogether too low for roads in the New York metropolitan area or where any considerable proportion of the traffic is trucks.

Studies which were made some time ago by the writer and S. Johannesson and set forth in detail in a paper presented to the Association of Highway Officials of the North Atlantic States, show costs of operating heavy trucks as high as 58c. per mile, of which 36c. per mile is chargeable to mileage. After investigating the whole situation and checking up various sources of information we arrived at the following figures as applicable to the highway which the State of New Jersey is building through the metropolitan area of northern New Jersey, between the New Jersey end of the Holland tunnel and Elizabeth.

We assumed that half the traffic on this highway would be heavy trucks, one-quarter light trucks, motor buses, etc., and one-quarter ordinary passenger automobiles, and that the costs of operation applicable to distance would be as follows:

50 per cent heavy motor trucks at	15c. per mile	7.5c. per mile
25 per cent light trucks and buses at	10c. per mile	2.5c. per mile
25 per cent passenger cars at	6c. per mile	1.5c. per mile
Average		11.5c. per mile

The cost per vehicle for each additional 1,000 ft. in distance is therefore approximately 2.18c., and assuming, as we did in this case, that there will be 18,360,000 vehicles per annum using the road, the value of the annual saving for 1,000 ft. in distance was $400,248, which, capitalized at 6 per cent, indicated that a sum of $6,670,800 might profitably be spent to save 1,000 ft. in length on this highway.

F. Lavis,
Consulting Engineer.

Jersey City, N. J.,
Aug. 6, 1928.

Bids Less Than Estimates

Sir—In your editorial headed "Bids Less Than Estimates," *Engineering News-Record*, July 26, p. 117, you say, "They can either build roads much more cheaply than highway engineers figure that they can be built for, or else they are building many roads without profit and perhaps at a loss."

As a resident engineer I have had an opportunity to study the work of various highway contractors and have made more or less of a hobby of analyzing their operations and recording these studies. As a result I would answer your statement by saying that the great majority of highway contractors do not know what their work does actually cost them and I believe that the division of management of the Bureau of Public Roads will bear me out in this statement.

Judging from my own experience, which covers periods in the past ten years, I should say that real cost-accounting systems among highway contractors are as rare as fur coats in Africa. And as for bidding, I have personal knowledge of a contractor at a recent letting who made a show of figuring the job and then after arriving at the letting and seeing the crowd sat down and cut his bid $15,000 on a $300,000 paving job. He had no cost records on which to base his bid in the first place.

Management studies of three jobs in this territory in the past year show that at least 25 per cent of the lost time is due to mismanagement; in one case the lost time amounted to nearly 50 per cent. The total lost time of the paver alone amounts to nearly one-half of the time the paver is on the job. While it is impossible to account for the losses in grading, the great majority of them are inexcusable.

The profits from concrete highway slab can be $300 to $400 a day net, under proper management at present prices, but the losses through carelessness and the absolute mishandling of the grading soon take up what the contractor makes on his slab. The final trimming of ditches and shoulders at a cost of 18c. to 25c. a lineal foot of road is far too high, and yet these are actual figures on a federal-aid project just completed.

D. V. Purington,
Resident Engineer,
Wisconsin Highway Commission.

Antigo, Wis.
Aug. 1, 1928.

Sir—Referring to your editorial of July 26, 1928, p. 117, entitled "Bids Less than Estimates," isn't it true that the engineer's estimate must be higher than an accepted bid in the case of public work? At least this is so in the city of Philadelphia where no bid may be accepted which is above a given estimate prepared and filed in advance of opening the bids, with the director of the department involved.

All bids higher than such estimate must necessarily be rejected, and to guard against the expense and delay of readvertising and assembling new bids it is evident that the engineer's estimate is likely not to reflect actual costs plus a fair profit, but includes such an addition as a safety factor as the engineer's judgment may direct.

Therefore while the engineer may have true costs at his disposal in preparing his estimate, he must play safe in his final total. A variation of 10 per cent is often seen between bids on the same job and is therefore not unreasonable between a low bid and a corresponding estimated cost.

S. W. Barakat.

Philadelphia, Pa.
Aug. 1, 1928.

Difficulties in Agreeing on Colorado River Compact

Sir—It is with some diffidence that, as a constant reader and warm admirer of *Engineering News-Record*, I take issue with your position as expressed in the editorial in your July 26 issue with reference to the Colorado River Compact.

This compact, more particularly designated as the Santa Fe Compact, has been ratified by five out of seven of the basin states and is made a fundamental part of the Swing-Johnson bill. The belief of some of the members of Congress from the upper basin states that the passage of this bill will make effective the Santa Fe Compact is their sole ground for not opposing it.

As one who was in close touch with the negotiations at Denver last summer I believe I can safely say that a revision of the compact was at no time considered or under discussion. The meetings were called expressly for the purpose of adjusting, if possible, certain differences between the two states which had not unconditionally ratified the compact, in order that the compact might then be ratified by all seven states. It was my good fortune to be in intimate touch with representatives of both states and, as such, to know how really close together were the sane elements on both sides. My individual opinion is that failure came about through too many cooks. Before the sessions were over there were involved not only the Governors of the states, their expert advisers and members of the congressional delegations but those representing various prominent interests in the two contending states.

I think it a fair conclusion that if the effort to adjust differences between two states failed through confusion of tongues the same fate would overtake any attempt to build a new agreement from the ground up.

The Santa Fe Compact is far from a perfect document. My advice to its critics has been to devote an hour or two to dipping into the transcript of the hearings held by the original Colorado commission. No intelligent reader can do this without concluding that it was a wonder that any compact at all was evolved out of the conflict of interests presented. That the Santa Fe Compact evaded the purpose of appropriating the river's waters among individual states was due to the task set before the original commission being far too difficult and complicated to be within present solution in final form.

George M. Bacon,
State Engineer.

Salt Lake City,
Aug. 1, 1928.

News of the Week

New York Subway Contract Awards

Extension of the New York Subway system has cost $203,000,000 for the 39 contracts let to date. The latest awards announced are as follows: Rosenthal Engineering Contracting Company, section along Jay and Smith Sts., from Willoughby to Baltic St., Brooklyn, $4,880,737.50; Sprague & Henwood, section along Broadway, Queens Boulevard and Kew Gardens Road from Steinway to Hillside Ave., Queens, $7,700,000. Bids have been received for the western extension, from Sixth to Eighth Ave., of the Fourteenth St. Eastern subway line. The low bid of $3,160,000 was submitted by D. C. Serber.

Natural Gas to Be Imported

Surplus natural gas from the Province of Alberta, Canada, will be available in the neighboring State of Montana by next winter, according to present plans of the Range Oil & Gas Company, of Calgary, Alta. The company has obtained a permit from the Canadian government to export natural gas to the United States from the Rogers-Imperial well located 25 miles east of Coutts and 4 miles north of the international boundary. It is proposed to construct a pipe line this year to the United States boundary and through Montana, either to connect with the present pipe line to the city of Great Falls or as a separate line to be supplied with gas from the Rogers-Imperial dome. It is expected that the supply of gas to Great Falls will start on the initial basis of 10,000,000 ft. daily.

Denver Leases Moffat Pioneer Bore for Water Supply

To establish priority of water rights on the three major watersheds of the Western slope, the Fraser, Blue and South Williams Fork Rivers, the city of Denver has taken definite steps to lease the pioneer bore of the Moffat tunnel from the Moffat Tunnel Commission. Plans for the present are to lease the water tunnel for five years at $1 a year and to spend not exceeding $50,000 a year for maintenance, which will be mostly concrete lining. Ultimate plans call for the tying up of the three rivers by a system of 42 miles of canals and complete lining of the tunnel to cost $4,475,000 and deliver 308,000 acre-ft. of water per year. During the ensuing five-year period, it is expected the city will perfect plans for financing the tunnel project, complete engineering surveys, and make negotiations for a 99-year lease at a nominal rate.

Safety Rules to Be Written by National Committee of Industry

Construction Organization Invited to Take Leadership Forming Code

THE American Engineering Standards Committee will invite the Association of Government Labor Officials of the United States and Canada and the Associated General Contractors of America to assume joint leadership in the establishment of national safety rules for the construction industries. This action follows the decision of a general conference of representatives of all groups concerned with construction to recommend the establishment of national safety rules by the committee as a means of cutting down the great loss of life in the construction industries in every part of the country.

The actual work of formulating the rules will be in the hands of a sectional committee on which all of the major groups concerned with construction and accident prevention will be represented. The following organizations will be requested to name official delegates to the sectional committee: American Society of Civil Engineers, American Institute of Architects, American Institute of Steel Construction, Associated General Contractors of America, Association of Government Labor Officials, Building Officials' Conference, Building Trades Employers' Association, Bureau of Standards, Department of Labor, International Association of Industrial Accident Boards and Commissions, Nation Association of Builders' Exchanges, National Association of Building Trades Employers, National Association of Mutual Casualty Companies, National Bureau of Casualty and Surety Underwriters, National Safety Council, Western Society of Engineers.

To Hold Road Congress in Brazil

The program of the second Pan-American Road Congress, to be held in Rio de Janiero, Brazil, from June 19 to July 3, 1929, has been approved by the Brazilian Minister of Transportation. A number of subjects will be discussed: Methods of construction and conservation of roads, legislation, administration, finances and economics, education and many others. The meeting will be attended by representatives of the republics of the Pan-American Union and of various private associations and companies which have obtained admission. Voting power is limited to official representatives only.

Two New Railroads to Be Built in West Virginia

The Interstate Commerce Commission has approved the application of the Virginian & Northwestern Railway Company for permission to construct a new line to extend from a point of connection with the Guyandotte branch of the Virginian Railway to a connection with the Chesapeake & Ohio at Gilbert, W. Va., 40.6 miles, at an estimated cost of $7,500,000. The work is to be completed before Dec. 31, 1931.

At the same time the Guyandotte & Tug River Railroad Company was authorized to construct a branch from Wharncliffe to Gilbert, W. Va., a distance of 53 miles, at a cost of $2,500,000. The same date of completion is specified.

The application of the Chesapeake & Ohio Railroad for an extension from Gilbert to Mullins, W. Va., 43 miles, was denied.

Canada Plans New Power Project

The management of the Winnipeg hydro-electric system has prepared plans for a 100,000-hp. development at Slave Falls, on the Winnipeg River. The original plans for this project were on the basis of 65,000 hp., but demand for power in the Winnipeg district is growing rapidly and the additional amount of energy will be required before long. The Slave Falls project, therefore, will cost approximately $10,000,000 instead of the former estimate of $6,500,000. At the same time it has been announced that the near future will see an additional 35,000 hp. developed from the Point du Bois plant on the Winnipeg River, which is now producing 105,000 hp.

Another International Meeting of Engineers Arranged

An international meeting of engineers, surveyors and architects is to be held at Winnipeg, Manitoba, on Aug. 24-25 by joint arrangement of the Minnesota Federation of Architectural and Engineering Societies, the Engineering Institute of Canada (Winnipeg branch), the Association of Professional Engineers of Manitoba, the Manitoba Association of Architects, the Manitoba Electrical Association and the Association of Manitoba Land Surveyors. A technical session on Friday afternoon will be devoted to highway work, power development, and international relations. On Saturday there will be trips to engineering projects and a social meeting with a group of members of the American Society of Mechanical Engineers on their way to a regional meeting at St. Paul on Aug. 27.

Station 2-A of the Big Creek development will operate under a static head of 2,420 ft., with an initial capacity of 107,200 hp. Three different constructions are used in the penstock—the upper portion is of riveted steel (center); the middle section of banded pipe (right); and the bottom high-pressure pipe of seamless forged steel. The small tower-like building is the control house at the top of the long hill to the power house.

CONSTRUCTION PROGRESS ON NEW PLANT OF THE SOUTHERN CALIFORNIA EDISON COMPANY

Wanaque Aqueduct Construction Still Delayed

Still another engineering report on the design of the Wanaque aqueduct is to be made, this time by Metcalf & Eddy, of Boston, who have been engaged by Montclair, Bloomfield and Glen Ridge to report on the further changes in design advised by Fuller & McClintock, New York City, in a report to Passaic, Paterson and Clifton, in which it was proposed that the full head of the Wanaque reservoir be utilized and water pumped to the proposed aerator, on the assumption that aeration will be needed only a few months in each year. The North Jersey District Water Supply Commission, which is carrying out the Wanaque project as agent for Newark, Kearney and the six communities already named, has voted to adopt the Fuller & McClintock proposal, and to employ the firm named as engineers for the aqueduct, subject to agreement on fees and to the signing of supplemental contracts by the eight municipalities. The latter is necessary in any case, since several million dollars are required to finish the project in addition to the $20,000,000 or so to which the municipalities are already bound. The municipalities already named as having engaged Metcalf & Eddy to report on the changes proposed by Fuller & McClintock refuse to sign the supplementary contract until they are advised whether the new plan will be advantageous to them. The report by Metcalf & Eddy is expected by Sept. 15. For notes on the Fuller & McClintock report, see *Engineering News-Record*, April 26 and May 3, 1928, pp. 678 and 711. In various forms this controversy has been going on for over two years, the design of the aqueduct having been entrusted for a time to George A. Johnson, then returned to Arthur H. Pratt and Morris R. Sherrerd, chief and consulting engineer of the commission, and now again proposed to be entrusted to outside engineers.

Concrete Spans Replace Pontoon Bridge in Vermont

A two-span concrete bridge across the Winooski River at Burlington, Vt., has been completed and is now in service, replacing a pontoon bridge built and maintained by the U. S. Army engineers since the floods of November, 1927, carried away the original structure. Since that time an average of 4,000 vehicles and 4,000 pedestrians have crossed the pontoon bridge daily without an accident of any kind.

Suit Asks Abandonment of Mulholland Dam

A suit has been filed by a resident of Hollywood, Calif., against the Los Angeles Water and Power Commission asking that the reservoir behind the Mulholland dam of the Los Angeles water supply be drained because it is a menace to life and property in Hollywood. The application states that the dam, like the St. Francis dam, has been built without a cutoff wall at the heel, without inspection galleries, contraction joints or sufficient drainage pipes, and that seepage is visible through several cracks on the downstream face of the dam. It is stated that failure of the dam would mean property damage of $300,000,000, and great loss of life.

Allegheny County Plans Many Public Improvements

As noted in *Engineering News-Record*, July 5, 1928, p. 32, the people of Allegheny County, Pennsylvania, have approved a program of public improvements costing $43,680,000. These improvements are to be financed, for the most part, by 30-year bonds and represent an extremely diversified list of public improvements, including roads and boulevards, bridges, county park improvements, a community auditorium, a new county office building and a modern airport. On the ballot submitted to the people, the program was divided into seven questions so that there was opportunity afforded to approve or reject any or all of the items.

Question No. 1 called for the expenditure of $6,550,000 for the construction of new highways, reconstructing and widening existing highways, elimination of grade crossings and dangerous curves and the erection of safety barriers. No particular roads were specified on which this money was to be expended.

Question No. 2 called for the expenditure of $10,930,000 for four specified boulevards as follows: Moss Side Boulevard in the eastern section of the county at a cost of $890,000. Saw Mill Run Boulevard in the city of Pittsburgh at a cost of $1,162,000. Ohio River Boulevard along the north bank of the Ohio at a cost of $5,343,000. Allegheny River Boulevard along the south bank of the Allegheny River at a cost of $3,535,000. All of these boulevards, with the exception of the Moss Side, which will serve as a connecting link between the William Penn and Lincoln Highway routes in the exterior part of the county,

are situated in part within the city of Pittsburgh and will afford new avenues of entrance to Pittsburgh's Golden Triangle.

Question No. 3 called for $1,500,000 to be devoted to the improvement of two great parks recently acquired—one in the northern section of the county containing approximately 1,720 acres, and the other, in the southern section, containing 1,550 acres.

Question No. 4 called for $14,650,000 for the erection of a new $6,885,000 bridge across the Ohio River at McKees Rocks Borough; for the construction of new $3,540,000 bridge across the Ohio River at a location about ¾ mile west of the junction of the Allegheny and Monongahela rivers; for the reconstruction of the present South Tenth St. bridge, which is a feeder to the Armstrong tunnel, at a cost of $1,925,000, and for the reconstruction of an obsolete bridge over the Youghiogheny River near the village of Boston. In addition, $1,400,000 was set up for the reconstruction of various unspecified minor bridges in the rural sections of the county.

Question No. 5 called for $2,550,000 for the erection of a modern county office building.

Question No. 6 was for $6,000,000 to erect a community auditorium for the use of the people for exhibits, conventions, recreational and educational assemblages.

Question No. 7, in the amount of $1,500,000, provided for the acquisition of land and its development into a modern airport

All of the seven questions were approved by a two to one majority. The present program, when combined with a 1924 county bond issue of $29,207,000 and a 1927 city issue of $19,902,000, makes a total of $92,789,000 spent for public improvements in the Pittsburgh district in the past five years.

Local Boards Receiving Payment for Levee Work

Checks for amounts aggregating $1,500,000 have been sent to local levee boards on the lower Mississippi River as reimbursement for work done in emergency relief work. This money was appropriated by Congress during the last session to repay funds contributed by local interests to the Mississippi River Commission for emergency repair work and construction during the 1927 flood.

Bridge Cable Stretched Across Detroit River

The first temporary cable connecting the towers of the new Detroit River bridge was hoisted into place Aug. 8 with a formal ceremony. This cable, together with others to follow, will support a working platform from which the main cables will be placed. It is estimated that the $20,000,000 structure will be completed by July, 1929, nearly a year ahead of schedule.

Freeman Scholarship Not Yet Awarded

The traveling scholarship established by John R. Freeman has not yet been awarded, according to advice from the Committee on Freeman Fund, 33 West 39th St., New York City. To be eligible, applicants must be American citizens, technical graduates from a school of recognized standing and a junior professor or instructor or an assistant in a technical school in which hydraulics is an important part of the curriculum. The age limit has been increased to 35 years.

The sum of $1,600 has been made available for the scholarship of 1928-29, $400 to be paid to the successful candidate on Sept. 15, 1928, and the remainder in monthly installments of $100 for twelve months. The successful applicant will be expected to leave for Europe as soon after Sept. 15 as practicable.

Applications must reach the committee on or before Sept. 15, 1928.

European Briefs

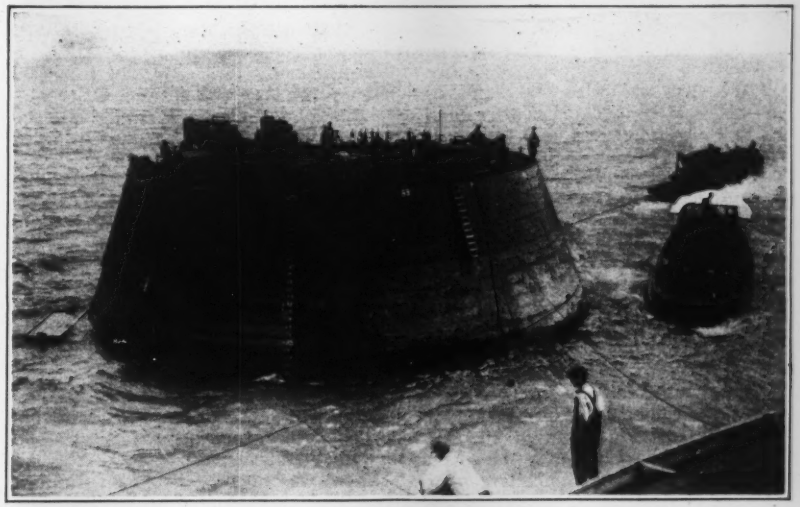
A Comprehensive Plan for the improvement of highway transport in Lancashire, England, has been presented in a report by a regional committee consisting of representatives of nineteen municipalities in the vicinity of Liverpool. The plan embraces a network of arterial and secondary highways, and recommends the improvement of existing main roads by widening and new alignment, the construction of new routes to fill the gaps in the system, the bypassing of towns and congested areas and the opening of new areas for building. Several new bridges are also recommended to divert the extremely heavy traffic to Blackpool, a popular summer resort, from the streets of Liverpool. The expected increase in highway traffic due to the pending completion of the vehicular tunnel under the Mersey River at Liverpool has caused the intensive study of which this plan is the result.

A Structural Material known as electron light and claimed to be 40 per cent lighter than duralumin is being used in a monoplane under construction by the Junkers Company, Dessau, Germany. Electron light metal is claimed to have a tensile strength and other mechanical properties equal to those of duralumin.

The Longest High-Tension Transmission Line in Europe, some 350 miles, connecting the Rhineland with the Bavarian and Austrian mountain hydroelectric plants, will be completed in February, 1929. A 200,000-volt line is planned to supplement the electrical power stations in west Germany, now operating on coal. The line current will, of course, be available in case of strikes or accidental shutdowns of the present power supply. Plans for extending the line to Switzerland have been made and work has already been started.

French Employers are urging modification of the eight-hour day law in an effort to increase the prosperity of the country. The workers' party is opposing the proposals, although it recognizes that they are not directed at the workman as such. It holds that any

CHICAGO PLACES NEW INTAKE CRIB



Towing the steel shell of the intake crib into position was a recent step toward the completion of the new intake shaft and tunnel for the Chicago water-supply system, described in *Engineering News-Record*, May 26, 1927, p. 860. This steel crib, which was built near the south side of the Navy Pier, is about 45 ft. high, with an outside diameter of 90 ft. at the base and 70 ft. at the top. Its inside cylindrical shell is 40 ft. in diameter, with eight horizontal radial intake ports approximately 8x10 ft. The total weight of the floating structure was about 700 tons. This crib structure was built by the Chicago Bridge & Iron Works, under the direction of Loran D. Gayton, city engineer, and J. J. Versluis, engineer of water-works construction.

attempt to introduce more elasticity into the provisions of the act will be backward step.

CONTRACTS FOR THE RECONSTRUCTION of the port of Bordeaux, France, involving new wharves and basins, have been let to the firm of Polensky & Zullner, Berlin, for $4,000,000. The work will be completed within the next 30 months.

CONSTRUCTION OF THE RAILWAY ANGORA EREGLI in Turkey has ceased because of lack of funds. The road, which has been under construction by the Swedish firm Nydquist, Holm & Company, will end at Filios on the Black Sea, and the Keller-Diarbekir line will end at Ismet Pascha, where rich copper ore fields will be exploited. It is reported that railway construction will again be taken up in about three years.

A SHIP TROUGH with a lift of 123 ft., to be used in place of locks, has recently been completed on the Hohenzollernkanal, connecting Berlin with Silesia. It replaces with a new channel the four locks which had been used in the original channel which caused much delay to shipping. The trough is 282 ft. long, 42 ft. wide, and passes ships up to 1,000 tons. It is of steel construction throughout and is lifted by 256 wire ropes in groups of eight strands connected to electric hoists.

EXTENSIVE USE of corrosion-resisting steel, made in the United States, in the construction of locks on the new Rhine-Lippe canal, was noted by Major D. I. Sultan, of the staff of the Chief of Engineers, who has just returned from Europe, where he went to attend the Brussels meeting of the Permanent Council of International Associations of Navigation Congresses.

ITALY DOES NOT INTEND further to subsidize its hydro-electric power plants, it is reported. The payment of 40 lire per horsepower in north Italy and 70 lire in south Italy, which has been paid since 1919, will be paid only on such plants as were under construction on June 30, 1928, and which will be completed not later than Dec. 31, 1930.

IN CERTAIN SECTIONS OF FRANCE agricultural machinery and tools produced in Austria, Hungary and Czechoslovakia are more than competing with American and Canadian machinery. As concerns Czechoslovakia this is in part due to the fact that these products are fabricated in state railway shops and are shipped out to compete with machinery produced in private plants. Further extensions of this policy may have far-reaching results. It is difficult for one country to control or influence the industrial and commercial activities of another; and, under the non-restrictive and no-contingent import and export regulations recommended by the League of Nations, there is nothing to prevent a government from producing goods for shipment across the frontier into another country, to the detriment of the latter's private enterprise.

Brief News

THE CONSTRUCTION OF AN IRRIGATION DAM on the Gila River above the new Coolidge dam, now nearing completion, will be considered at a hearing to be held in Washington Sept. 20 at the request of landholders in the area affected. The proposed structure will be financed by the landholders.

SURVEYS FOR A TRANS-ISTHMIAN HIGHWAY will be made by the United States as the result of the acceptance of an offer made to the Republic of Panama. Funds have been provided and the preliminary work will start soon.

NORTH PHILADELPHIA is to have a new $2,000,000 station of the Philadelphia & Reading Railroad at Broad and Huntingdon Sts. Ground was officially broken on Aug. 1.

THE COFFERDAM on the Diablo dam of the Seattle water supply was flooded by high water caused by unusually rapid melting of snow in the mountains. Work was not suspended, but the men were transferred to another part of the job above the water level.

CHANGING FROM STATE TO FEDERAL MARKING system on the highways of Pennsylvania involved the erection of about 70,000 new metal markers.

TWO STORIES of the structural steel framework of an addition to Langdell Hall, at the Harvard Law School, collapsed recently while being erected. One man was injured.

WASHINGTON NOTES

BY PAUL WOOTON
Washington Correspondent

Mississippi Board Reports—Reservoirs Often Restrict Roads—Government Bidding

DIVERSIONS from the Mississippi River through the Boeuf, Tensas, and Atchafalaya basins, as proposed in the report of the army engineers, but with certain modifications, were recommended by the board of three set up by the flood-control act in its report submitted to the President last week. The board, after a series of meetings following an inspection trip down the river and a period of intensive study, forwarded its report to the President, but its members agreed not to comment on their deliberations.

There was no disposition on the part of the board, it is thought, to favor any increase over the amount of water suggested in the Jadwin plan as the maximum to be carried in the Mississippi past New Orleans. It is known that the board had a detailed study made of the data collected when the Poydras and Caernarvon crevasses were running. The report, it is believed, recommends against any step which would increase velocities and scour in New Orleans. The effect of this would be the negation of the spillway below New Orleans. Before beginning work on the Bonnet Carre spillway, hydraulic laboratory tests will be conducted by the Corps of Engineers to determine the amount of scour that may be expected in the handling of 250,000 sec.-ft. through that outlet.

Wants Bids Audited

Auditing of Mississippi River Commission bids on levee work by disinterested accountants will be urged by the Associated General Contractors of America. After a conference in New Orleans with eighty levee contractors, General Manager Garber of the A.G.C. is convinced that these bids, which are based on hired labor operations, do not include all costs and cannot justly be used as yardsticks with which to measure the bids of private contractors.

Mr. Garber also plans to retain an engineer who will devote his entire time among the projects being handled by contractors, to gather data concerning the progress of their work and the treatment being accorded them.

Highways vs. Reservoirs

An increasing number of conflicts are arising between officials in charge of highway construction and development and those dealing with the utilization of water resources. The construction of dams in streams and the creation of large reservoirs adds to the expense and difficulties in carrying roads across or around such reservoirs.

In the west, the reservoir areas usually are controlled by the Department of Agriculture through the existence of national forest reserves, or by the Federal Power Commission through power site reserves. The solution involves an intricate economic analysis to determine whether or not it is in the public interest to give the highway an interior location, or to build a bridge and add the cost to the rates which will be charged those who use the water for irrigation purposes, or those who will have it added to their electric power bills.

The application of the Empire District Electric Company, which involves the construction of the Table Rock reservoir on the White River, in Missouri, is being indefinitely delayed because the power company would not be justified in making the development if it has to pay for a bridge necessary to the continuation of direct highway communication with the adjacent territory on the two sides of the stream.

Cases of this character present unusual difficulties. An example involving the same fundamental questions is had in the conflict between Los Angeles and Pasadena in connection with the proposal of Pasadena to construct a water-supply reservoir in the San Gabriel River below the site of the flood-control reservoir which Los Angeles plans to build. Pasadena finally has secured rights to construct its reservoir, despite the fact that this will make necessary

a much larger expenditure in the construction of the Los Angeles project, since the railroad necessary for transporting materials will be prevented by the Pasadena reservoir from following the edge of the stream, and will have to occupy a more difficult location where construction costs will be greater.

Awarding Official Contracts

A recent case in which officials of the Navy Department were compelled to award a contract to the low bidder, even though they had good grounds for believing him incompetent, has focused the attention of department heads once more on the question as to what constitutes a responsible bidder. In this connection, much interest has been attached to a report that certain arrangements are afoot whereby the Comptroller General will withdraw his objections to the Cramton bill, the passage of which would clarify the situation regarding a responsible bidder.

The Cramton bill states that contracts shall be awarded to those whose bids are the most advantageous to the government, price and other factors considered. The bill further states that in cases of doubt as to which bid is the most advantageous to the government, the head of the department supervising the work shall have final decision. The Comptroller General opposed this last provision during the hearings at the last session of Congress. It is understood, however, that he is now willing to acquiesce providing the bill stipulates that the government official awarding a contract to other than the low bidder must put his reasons in writing and file them with the contractors.

Questions have been raised by some of the government departments as to the provisions of the public contracts act intended to strengthen the policy of giving preference to American materials in public construction work, recently made a part of the standard contract form. To clarify the situation, Major E. W. Cushing, counsel for the Bureau of the Budget, has explained that nothing in the regulations would prevent a contractor using foreign materials from obtaining an award as long as he was the low bidder. The only requisite for such a bidder, under the new provisions, is that he must announce his intention of using foreign materials.

However, when a contractor, after having been awarded a job, desires to make a substitution of cheaper foreign material, he will not be permitted to do so unless he is willing to extend part of the benefit of his saving to the government. For the government to require a low bidder announcing his intention of using foreign materials to reduce his price still further would be tantamount to imposing a double import duty on the material concerned, Major Cushing pointed out. In fact the British and French embassies have protested formally against an interpretation of the act that would bring about this alleged discrimination.

Engineering Societies

CALENDAR

ANNUAL MEETINGS

AMERICAN WATER WORKS ASSOCIATION, Central Section, Pittsburgh, Pa.; Annual Meeting, Huntington, W. Va., Aug. 23-24.

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Convention, Montreal, Canada, Sept. 18-21.

NATIONAL SAFETY COUNCIL, Chicago; Annual Meeting, New York City, Oct. 1-5.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; Fall Meeting, San Diego, Calif., Oct. 3-5.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Convention, Detroit, Mich., Oct. 22-28.

THE ASSOCIATED GENERAL CONTRACTORS, Mississippi Valley Flood Control Chapter, held a meeting in New Orleans, La., on the morning of Aug. 12. The speakers were D. A. Garber, general manager of the A.G.C., and Henry J. Kaiser of Oakland, Calif.

THE ATLANTIC DEEPER WATERWAYS ASSOCIATION will hold its annual convention at Cape May, N. J., Sept. 4-8.

THE AMERICAN WATER WORKS ASSOCIATION, Wisconsin Section, will hold its annual meeting October 11-13 at Menosha, Wis. L. A. Smith, of Madison, Wis., is secretary.

Personal Notes

COVINGTON K. ALLEN, an engineer who has been connected with the Bureau of Street Cleaning, Baltimore, one of the divisions of the Department of Public Works, has been appointed temporary head of the bureau. Mr. Allen, who is a member of the American Society of Civil Engineers, has been in the employ of the municipality at various intervals since 1899. He was associated with the Electrical Commission, the Sewerage Commission, School Department, and the Water Department. He also has been in the employ of the Pennsylvania Railroad.

Lieut. Comdr. JAMES T. MATHEWS, Civil Engineer Corps, U. S. Navy, has been relieved of his duties at the Naval Submarine Base at New London, Conn. He will be assigned to the staff at Pearl Harbor, Hawaii.

Lieut. Comdr. C. H. COTTER, Civil Engineer Corps, is in charge of the construction of the naval ammunition depot being erected at Hawthorne, Nev.

WILLIAM M. SPANN has left the Missouri State Highway Department to take charge of a $6,500,000 road-building program for Jackson County, Mo., in which is situated Kansas City. Mr. Spann has been city engineer of Jackson, Miss., and Miami, Fla., and has also been construction and division engineer for the Montana Highway Department.

Obituary

SAMUEL GEORGE ARTINGSTALL, well known consulting civil engineer, and for many years city engineer of Chicago, Ill., died in that city Aug. 7 after an illness extending over several years. Born in Manchester, England, he was brought to Chicago by E. S. Chesborough, Chicago's first city engineer, who was then in England making studies for the city's first water and sewerage system. Mr. Artingstall was put in charge of and designed the general water system, including the pumping stations at Chicago Avenue, Lake View, 22nd Street and 14th Street, together with the connecting lake tunnels and cribs. He also instituted the first intercepting sewer system and the original river straightening at what is known as Goose Island. He designed the notable 12th Street viaduct and also developed the design for the first mechanically operated swing bridge, at Rush Street. He appointed and was ex-officio member of the commission to investigate the Chicago sewage system and proposed the creation of the Sanitary District of Chicago, later becoming chief engineer, resigning to become chief engineer of the Chicago World's Fair. He resigned from this to again accept the position of city engineer under the elder Carter H. Harrison.

Mr. Artingstall enjoyed an extensive private engineering practice and was engaged as consultant by many cities and corporations. He designed the water system for Santiago, Cuba, and was consulting engineer for the government of Chile on proposed $50,000,000 harbor improvements. He was one of the founders and past president of the Western Society of Engineers, member of the American Society of Civil Engineers, and the Institute of Civil Engineers.

JOHN WESLEY BALL, highway engineer with the U. S. Bureau of Public Roads, with headquarters at San Francisco, Calif., died July 22 at the age of 39 of a heart attack brought on by inflammatory rheumatism. A graduate of Purdue University, Mr. Ball entered the service of the Bureau of Public Roads in 1915 as a junior highway engineer. He was connected with a number of notable road-building projects in the national forests and parks of the West, including the 70-mile road connecting Medford, Ore., with Crater Lake National Park, which cost over $1,000,000. At the time of his death Mr. Ball had charge of the administration of national forest road in eleven western states and Alaska, involving from $7,000,000 to $9,000,000 in construction annually. He was a member of the American Society of Civil Engineers.

Construction Equipment and Materials

Concrete Road Yardage

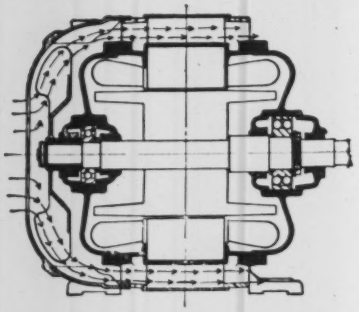
Below is given a tabulation of concrete pavement yardage awarded during July, 1928, together with the total number of square yards awarded in roads, streets and alleys, for the year to July 28, as prepared by the Portland Cement Association. These figures represent awards in the United States only.

	Sq.Yd. Awarded	
	During July	From Jan. 1 to July 28
Roads	6,983,781	60,412,597
Streets	5,845,606	30,362,274
Alleys	293,989	2,084,122
Totals	13,123,376	92,858,993

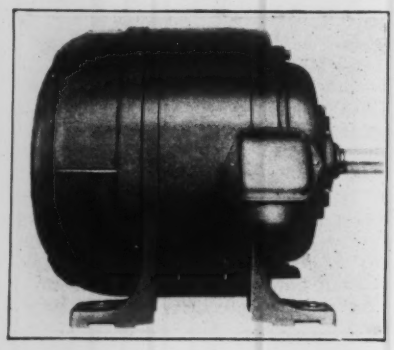
New Developments

New Motors Made Dust Proof by Integral Fan and Air Jacket

An air-jacketed motor for serving where dust, fumes and moisture are present in sufficient quantities to necessitate protection to motor and property has been developed by the Wagner Electric Corporation, St. Louis, Mo



The entire motor is surrounded by a jacket open at both ends, with fan blades on a shaft extension between the sealed motor and its outer jacket. The only clearance between rotating and stationary parts of the motor is in the bearing housing—and here no impurities can get past the grease packing. (See cross-section sketch.)



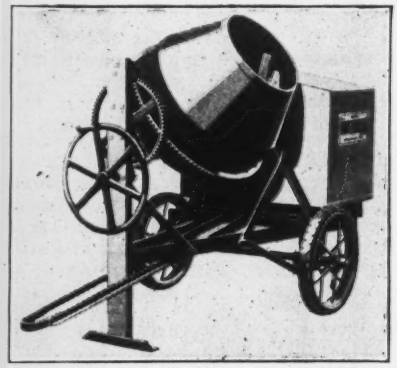
The motors are new in external construction only; no changes have been made in the electrical principles. The frame housing, the motor proper and all bearings are substantially air-tight. The end shield is made of cast iron, is rib-reinforced, and has a substantial grating which protects the fan and provides an opening for incoming ventilating air. The center shield is made of heavy sheet steel held in place by slot-head bolts. The fan is of one piece construction. The conduit box is mountable in four positions.

The stator is the only part of the standard single-phase repulsion-induction and polyphase squirrel-cage motors subject to change in design. The exposed outer rim is deeply grooved to increase the radiation surface. The punching for windings remains unchanged. The stator laminæ are welded together to lessen vibration and reduce magnetic noises.

The motors have double-row ball bearings, self-aligning in one end plate and deep grooved in the other to take end thrust. Bearings are grease lubricated and sealed in a dust-proof housing. The shafts are made slightly longer than those for standard motors to permit fan mounting. Single-phase repulsion-induction motors may be had in sizes from 1 to 20 hp., and polyphase squirrel-cage motors in sizes from 2 to 30 hp. These motors are designed for a temperature rise not to exceed 50 deg. C. and to meet all A.I.E.E. and N.E.L.A. standards.

A New 3½-Cu.Ft. Tilter

A new tilting batch mixer of 3½ cu.ft. capacity is announced by the Knickerbocker Company, Jackson, Mich., whose concrete mixers have heretofore been

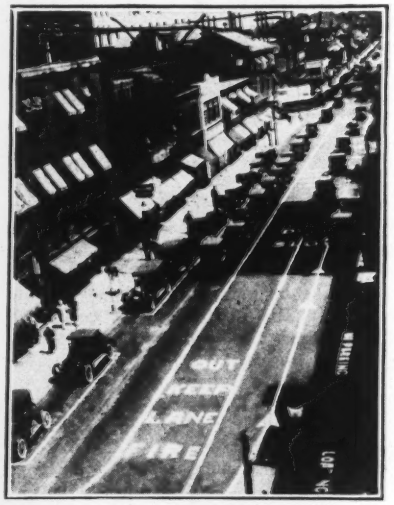


confined to the drum type. The new Knickerbocker tilter has been designed to fill the need of the contractor for an easily portable model of relatively small capacity. The drum bottom is a one-piece semi-steel casting to which is bolted a heavy 6-in. steel band. The drum cone is riveted to this band. It is claimed that the 6-in. middle section of the drum together with the shape, number and placement of the mixing paddles produces a mixing action closely approximating that in the company's non-tilting drum-type mixers.

The shaft has a bearing area 20 in. long and revolves with the mixer. In mixing position the thrust of the load and barrel is taken by a Timken roller thrust bearing sealed from grit and water. Power supplied by a 2-hp. Stover engine is applied by malleable pintle chain drive to a sprocket on the main drive shaft. Easy portability is achieved by the perfect balance of the outfit and the coil spring mounting over the axle.

Marking Streets With Canvas

Painting on street surfaces is eliminated by the use of traffic markers produced by the Wamblu Corporation of Rochester, N. Y., which are made of strong canvas, paint-impregnated, whose backs are coated with an adhesive which makes permanent application easy. The markers are made in strips, disks, and letters in various sizes and combinations and in various colors. Besides



the usual application to street pavements, the markers have been used on poles for route markers, on roofs for the guidance of aviators, and in other places where legible lettering or marking is necessary. Application can be made in a short time without the use of skilled labor. Traffic may be permitted to cross the markers immediately, for the pressure of the wheels and the heat of the sun act to vulcanize the strips to the pavement.

A Plaster Mixer With a Hoist

Installation of a hoist on its plaster mixer, "the mechanical hoeman," has been announced by the Marsh-Capron Company, 11 South La Salle St., Chicago, Ill. The hoist is mounted on the countershaft of the mixer and can be operated while mixing or independently. It is provided with an automatic brake which holds the load when the clutch is

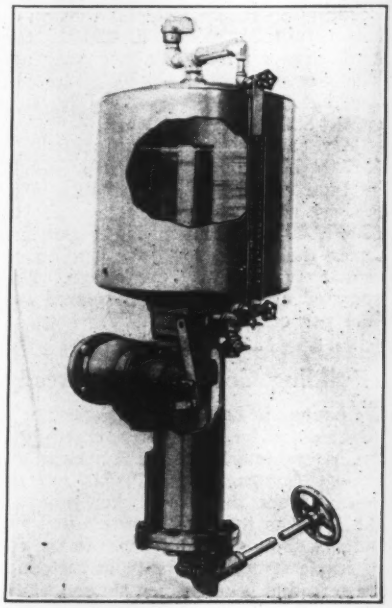
disengaged. The large winch head projects in the front of the machine, making it easily adapted for the operation of elevators or other hoisting work. The standard engine equipment, a 2-cyl., hopper-cooled Le Roi or Novo, has been found to give ample power for a large amount of hoisting work.

Another improvement recently announced on this plaster mixer is a new stuffing box on the hoe shaft. A semi-metallic packing is used in an outside stuffing box mounted in a cast head in the drum head casting. The packing can be changed at any time without dismantling any other part of the machine and the packing glands can be tightened while the shaft is revolving. An open space between the stuffing box gland and the bearing prevents plaster from working into the bearing housing, thus assuring long bearing life. The machine is provided in two styles of mounting—a four-wheel rubber-tired trailer, with telescoping steel hauling hitch where a high degree of portability is desirable, or on a truck with four steel wheels.

Paver Water Tank Designed for Extreme Accuracy

The constantly growing realization of the importance of the water-cement relation in concrete for roads and streets is anticipated in the use of a new design water measuring tank by the T. L. Smith Company, Milwaukee, on its 1928 model paver. The new tank shown in the accompanying illustration is claimed by the manufacturer to measure water accurately to the ounce. The design follows the practice of manufacturers of pumps used in measuring liquids for sale as in gasoline filling stations.

The claim is made that the accuracy of the tank is unaffected with the paver operating on a side or up- or down-hill slope. The amount of water discharged is varied by raising or lowering a central pipe of large diameter through a handwheel on the operator's platform. The tank and valve are self-cleaning and the regulating parts are non-rusting.



Business Notes

SMITH TRAILER CORPORATION, Syracuse, N. Y., has purchased the tracings, blueprints, patterns and templets for the Watson bottom dump tractor wagon formerly manufactured by the REX-WATSON CORPORATION, Canastota, N. Y., and will continue the sale and manufacture of similar wagons to be known as the Smith trailers. The 3- and 6-yd. models will be equipped with round wheels and two new models of 7- and 10-yd. capacity respectively will be equipped with crawlers. Harold P. Bentley, production manager, formerly connected with the Watson corporation, will be in charge of production, and R. Shaw Goldthwait, formerly with the Watson corporation as sales manager, will direct the sales of the new corporation.

GLOBE-WERNICKE COMPANY, Cincinnati, has purchased the Steel Equipment Corporation, Avenel, N. J. The latter company will continue to function as heretofore with no change in active officers or sales force. The purpose of the affiliation is solely to effect production and engineering economies.

SULLIVAN MACHINERY COMPANY, Chicago, announces the appointment of several new distributors as follows: New York City—United Hoisting Company, Inc., 136th St. and Locust Ave.; Salt Lake City—Eastern Iron & Metal Company; and Sacramento, Calif.—Standard Equipment & Supply Company.

UNIVERSAL PORTLAND CEMENT COMPANY, Chicago, announces that A. C. Cronkrite has been appointed assistant general sales manager; Edward Quebbeman, Western sales manager; W. L. Greenly, division sales manager for Chicago; Harry A. Craig, division sales manager for Illinois and Missouri; and Earle D. McKay, division sales manager at Duluth.

T. L. SMITH COMPANY, Milwaukee, Wis., announces the appointment of A. J. Gerlach as advertising manager. Mr. Gerlach was previously advertising manager of the Sterling Motor Truck Company.

BETHLEHEM STEEL COMPANY, Bethlehem, Pa., announces that Paul Mackall has been appointed vice-president in charge of general sales, succeeding E. S. Knisely, that Mr. Knisely has been appointed assistant to the vice-president and that H. G. Walton has been appointed general manager of sales. Also it is announced that V. A. Jevon, who has had charge of structural and plate sales in the Pittsburgh district since 1919, is appointed manager of the structural and plate sales at Chicago, succeeding Lee Hillard, assigned to other duties; A. G. Williams, formerly sales agent of the Bethlehem district, has been appointed manager of structural and plate sales at Pittsburgh. Alfred B. Scott has been appointed agent for the Bethlehem district.

Manufacturers and Trade Associations

CALENDAR

ANNUAL MEETINGS

TRACK SUPPLY ASSOCIATION, Chicago; annual exhibition and convention, Detroit, Sept. 18-20, 1928.

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; semi-annual meeting, Buckwood Inn, Shawnee-on-Delaware, Pa., October 1-3, 1928.

New Publications

Special Concrete—AEROCRETE CORPORATION OF AMERICA, New York City, has published a 12-page booklet describing the use of its product "Aerocrete," which is a special concrete, mixed in an ordinary mixer and allowed to expand in the forms. The expansion is caused by the expansion of gases and results in a concrete claimed to be light in weight, fire resistant, sound and heat resistant, and strong depending upon the density.

Concrete Mixers—KNICKERBOCKER COMPANY, Jackson, Mich., has published Catalog No. 28. It is a 40-page booklet describing the company's various types of concrete mixers, telling how the machines are designed and built, giving illustrations and descriptions of the mechanical details of the various models and sizes and including photographs and descriptions of a number of construction jobs upon which the company's mixers have been used.

Pipe Couplings—S. R. DRESSER MFG. COMPANY, Bradford, Pa., has published an 111-page catalog, giving complete information on its sleeves, clamps, fittings and other standard accessories for the construction, maintenance and operation of oil, gas, air and water lines for wrought- and cast-iron pipe. Illustrations of all of the various products are given and tables of dimensions and types are included for all ordering purposes.

Gasoline Locomotives—GEO. D. WHITCOMB COMPANY, Rochelle, Ill., has devoted a new bulletin 2824 to its narrow gage gasoline locomotives ranging in size from 10 to 30 tons. Illustrations are given of the various machine details, and tables are included giving all specifications, speed, and drawbar pulls. In addition, tables of specifications for Climax and LeRoi gasoline engines are given.

The Business Side of Construction

World Trade in Cement

World production of cement for 1927 is estimated at 396,541,730 bbl., compared with 230,889,701 bbl. in 1913. Of this 165,652,000 bbl. increase, the United States accounts for 81,109,000 or 49 per cent, according to C. F. Stephenson, Minerals Division, Department of Commerce, in an article in the July 30 and Aug. 6 issues of *Commerce Reports*.

Potential capacity of all cement mills at the end of 1927 is estimated at 541,510,000 bbl. Cement entering international trade in 1927 amounted to 35,176,548 bbl., compared with 26,525,312 in 1913. Thus, while production has increased 72 per cent in thirteen years, exports by the leading cement producing countries have increased only 33 per cent.

Belgium, from both a natural and an economic standpoint, is preeminently fitted for the manufacture and exportation of cement. Its large modern plants, producing 2 bbl. per capita, are located close to excellent raw materials and fuel, with inland transportation costs to the seaboard only 28 to 42 cents per metric ton, according to haul, with low production costs, and cheap ocean freights. Its per capita production compares with other countries as follows: United States 1.46 bbl., Denmark 1, Norway 0.8, and Germany 0.7 in 1927.

German cement output in 1927 equaled that of 1913 for the first time since the war. A syndicate controls the industry and most of the companies are members of one or another of the cartels. The principal activity of these cartels is regulation of prices, production and sales within Germany. Despite this close control and the high tariff the German cement industry is not very prosperous. Wages have increased 100 per cent since 1913, whereas per man production has increased only 30 per cent. The standard tariff rate is 61 cents per barrel, and for countries which have most favored nation treaties 30.5 cents.

France with a capacity for producing 41,423,700 bbl. produced 27,678,950 in 1927. Conditions in the industry were not good last year and prices remained firm only because they were fixed by the National Association of Cement Manufacturers. With respect to the export trade, the manufacturers were satisfied to have been able to hold their own in sharp competition with Belgium.

The United Kingdom has an estimated capacity of 31,000,000 bbl. and the industry is in satisfactory condition, with heavy production last year and shipments exceeding those of any previous year. Two groups—the Associated Portland Cement Manufacturers, Ltd., and the British Cement Products and Finance Company, furnished 65 to 70 per cent of the cement produced. A few months ago the former group announced a dividend of 8 per cent on ordinary shares for 1927, double the rate paid in 1926, while the latter group paid 15 per cent as against 12½ per cent in 1926. Exports have been gradually increasing since the war and now approach 4,500,000 bbl. Imports, which have been increasing, amounted to 1,983,000 bbl. in 1926 and 2,502,000 bbl. in 1927, with Belgium the principal source, followed by France and Denmark. The cement imported is of lower grade than the domestic product.

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended Aug. 14, with some comparisons, total as follows:

(In Thousands of Dollars, 000 Omitted)

Week Ended	Public	Private	Total
Aug. 14, 1928	**$25,473**	**$39,524**	**$64,997**
Aug. 7, 1928	34,211	43,432	77,643
Aug. 16, 1927	29,536	25,441	54,977
Jan. 1 to Aug. 14:			
1928	849,927	1,399,143	2,249,070
1927	756,576	1,140,162	1,896,738

E. N.-R. Index Numbers

Cost		Volume	
Aug. 1, 1928	**207.29**	**July, 1928**	**266**
July 1, 1928	206.65	June, 1928	308
Aug. 1, 1927	205.50	July, 1927	252
Average, 1927	206.24	Average, 1927	263
Average, 1926	208.03	Average, 1926	228
1913	100.00	1913	100

Industrial Buildings Fewer; Average Value Higher

The 826 industrial building contracts of $40,000 or more reported in the first seven months of 1928 averaged $206,177, whereas the 1,027 of 1927 averaged only $148,346.

Substantial gains in the value of contracts awarded are recorded in the following classes: foods, textiles, leather, paper and pulp, coke, manufactured gas, paints and varnishes, glass, automotive and garages, printing and binding, foundries and refrigeration. Particular activity is noted in the south and west. The middle Atlantic states show a decrease, with New England about the same as last year.

Certain other classes show marked differences that require explanation. In manufactured gas the heavy gain is due to an award in January for the Delaware River plants of the United Gas & Improvement Company, of Philadelphia, valued at $8,000,000. In the case of rayon an award in March for a $10,000,000 plant at Richmond for E. I. du Pont de Nemours & Company boosted this year's total. The glass industry reports two large additions this year: A plant at Ford City, Pa., for the Pittsburgh Plate Glass Co., $2,000,000, in March and a plant at Creighton, Pa. for the Pittsburgh Safety Glass Co., $1,000,000, in June.

Automobile Output Continues at High Rate

The automobile industry in July maintained high production, as in the first six months. Production for the first seven months is close to that of the record year, 1926, and predictions are made that 1928 will establish a new high record. Preliminary reports indicate that Chevrolet shipped 120,000 cars and trucks in July, compared with 87,134 a year ago. Buick produced 15,000 cars, is turning out 900 daily, and August shipments are expected to reach 32,000. Graham-Paige established a new production record in July, exceeding any previous month in the eighteen years of the factory's existence. Production reached 8,829 cars, with shipments of 9,010. Nash shipped 17,891 cars, making July the second largest month in the company's history. Orders received last month totaled 31,049 units. Packard shipped 3,805, compared with 3,080 a year ago, and August shipments are expected to reach 4,800 cars. Studebaker retail sales were 12,600 compared with 13,000 for June and 8,733 for July, 1927. Graham Brothers Truck Division of Dodge Brothers, Inc., reports the best July business in its history, and the heaviest sales since June, 1926.

Cement and Steel Output Ahead of a Year Ago

Steel ingot output for the first seven months of 1928 gained 5.8 per cent over that of the same period of 1927. Cement output for this period is 2.1 per cent greater than for 1927. Cement shipments are 0.09 per cent greater than last year and stocks 16.5 per cent heavier.

Steel mills are operating at 83.83 per cent capacity compared with 81.55 a year ago, monthly averages. The July output was 3,811,573 tons, which is 1.5 per cent greater than for June and 19 per cent ahead of July, 1927. The unfilled tonnage statement of the Steel Corporation shows 3,570,927 tons on the books July 31, which is 428,913 tons more than on that date one year ago. This figure, however, is 56,082 tons below that of June 30, 1928. July, 1927, gained 88,768 tons over June.

July cement production totalled 17,431,000 bbl. compared with 17,469,000 in June and 17,408,000 in July, 1927. Reserve stocks at mills on July 31 were 22,571,000 bbl., which is 10 per cent under the figure for June but 16 per cent heavier than a year ago. Mills operated at 87 per cent compared with 90.4 per cent in July, 1927.

Building Costs Remain Steady

Changes in building costs continue so slight as to be negligible, according to the index numbers of the American Appraisal Company. July costs are one point higher than those for June and the same as those of a year ago. July indexes show slight advances in the cost of frame structures except in the southwestern and southeastern states.